Concrete

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How Good Is Business

IT is a fault too general perhaps in American business that it attunes its operations to the productive necessities of times that are above normal, and then makes a wry face at and senses a depression in the slightest tendency toward the inevitable slackening in activity that comes with more nearly normal demand. The salesmanager forgets that were there no slopes, there could be no peaks.

The construction business is good. It is not quite so good as it was in the spring. There is some feeling in the east that it was too good then. If the west and middle west did not do quite so well as the east in the earlier months of 1924, these sections find very solid satisfaction in the prosperous air of the farmer, which is almost always reflected favorably in the construction field as in other industries.

Cement production and sale are in a very good way. Shipments in June broke all records, and July production figures hit a new high mark.

Building costs have eased off a little. Further declines are not generally looked for, and a gradual increase in demand toward the end of the usual building season, and another quickened demand very early in 1925 are rather generally predicted. Probably no one would have sensed that we have come through any depression—if depression it may be termed—but for the period immediately before in which building activity was hitting very high levels. Just how good the situation in the building field is, is indicated in some measure by the fact that builders' costs are still 86% higher than in 1914, while all the other costs of living are but 61% higher. The construction business is good.

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Paying the Piper in England

CHARLES MARQUES, writing for CONCRETE from England, assures us that human nature, good and bad, is of much the same general order on both sides of the Atlantic. "The crime of the nineties," for which the concrete masonry unit has been paying the penalty for some time, has been perpetrated in England in more recent times. The "shovel and gravel pit" operator has done almost if not quite his worst over there too, as he did here, and left the serious, intelligent later-day manufacturer to make the best of the wreckage from the inevitable collision with public opinion. England has, in all probability, as many separate and distinct varieties of bad concrete as we have on this side—and from the same causes. Their plight is not cited to condone our shortcomings, but as a warning that such ignorance and methods produce about the same results in all cases.

There is another view. A recent visitor in England finds that among those manufacturers of building units who have survived the hasty general adoption of these products, on the false supposition that concrete is concrete, willy-nilly—who survived to demonstrate that making good concrete is a very particular enterprise—among them there is a commendable demand for higher standards than we demand over here. America wants production—quantity. England, with cheaper labor, is at more pains to get quality.

* * *

Hobgoblins

THE only sure way to make a business or an industry grow is to improve the fundamentals on which it is based. There are certain words of which some concrete men have been afraid. They held up their hands. Some were awed at the mention of crazing; others at efflorescence; a few at alkali and sea water; others at corrosion of steel. These things were to be mentioned in whispers. There is nothing to be gained by poking one's head in the sand. Such difficulties yield usually to more complete understanding, as some of these very difficulties are now yielding.

Put concrete alongside all other construction materials, and the concrete man may see how far he has come in a remarkably short time; how many hobgoblins have been banished. There are still at work in some conditions, certain damaging agencies, and to study them is to learn more about the material—where and how and why to use it. One of the hopeful things in the whole field of concrete is that its leaders are not afraid of facts, but try to find their meaning. Facts are reputed to be hard things. But most of them are only tentative. A fact yesterday becomes a memory today. A willingness to junk one set of facts for another, and to stand in no awe of an idea, is the open sesame of progress.

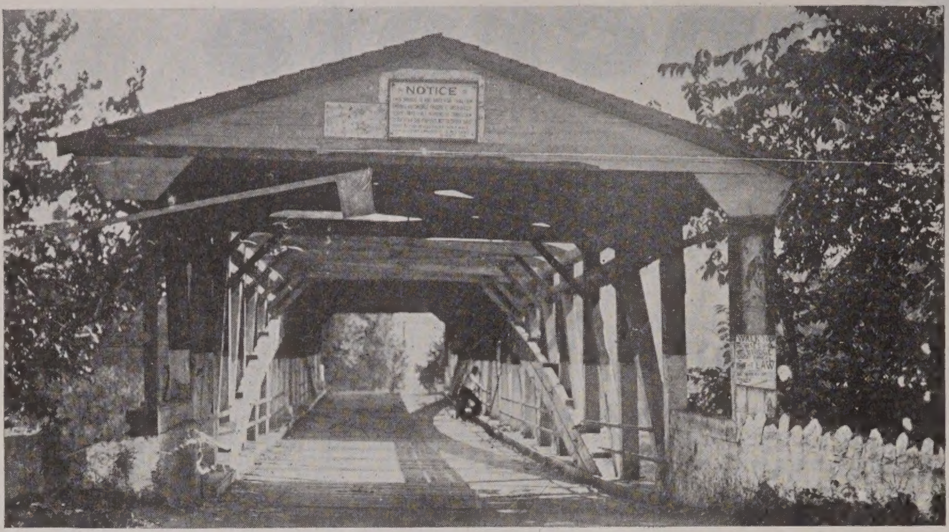
* * *

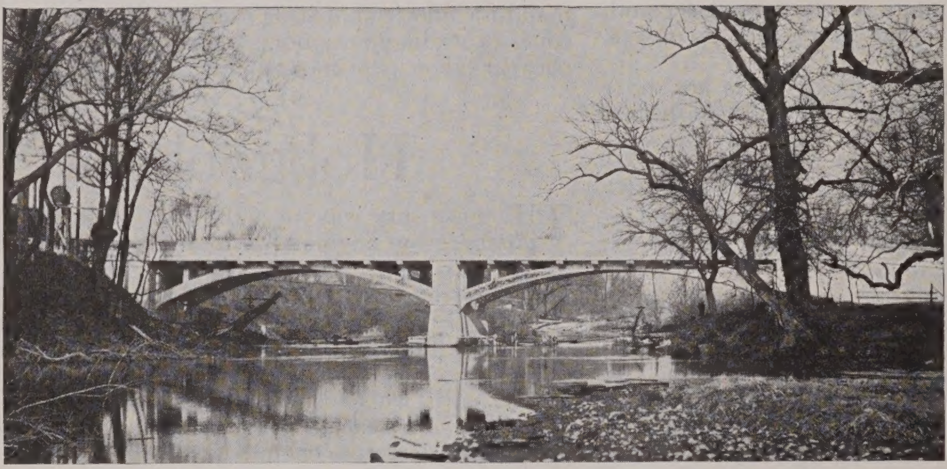
Quality Products

AND what are the elements of quality in the production of concrete masonry units? A. J. R. Curtis, manager of the concrete products bureau of the Portland Cement Association, finds that quality is dependent upon six factors. Here they are:

1. Suitability of the aggregate, taking into account both character of their constituent material and gradation of the particles.
2. Consistency of the mixture.
3. Amount of cement used.
4. Thoroughness of mixing.
5. Efficiency of the molding or casting process.
6. Curing methods.

We are especially warned against fine sand; the use of coarser aggregate is a sure way to increase strength and reduce costs.





Old and New Bridges at Chadds Ford, Pa.

Traipsing through the musty pages of the last hundred years in order properly to celebrate in our October issue the centenary of portland cement begets a humor which pauses at many old things that are being replaced by new ones.

For instance, here is the bridge that did service for something over half a century at Chadds Ford, Pa.,—and below it the new bridge of concrete which has lately taken its place.

This is on the famous Washington Trail, Route 131, of the Pennsylvania state highway. The new bridge completes this famous highway, which is now very largely made up of concrete construction from New York to Washington. It has two spans, and presents a very pleasing picture as viewed from a point to the south. It cost the county about $100,000, and will obviate the necessity of another structure for many years to come. The bridge which preceded it was just about ready to fall down, and was a continual menace to travelers when it was done away with in 1922.

The first application for a boat or ferry at Chadds Ford—called so because John Chadds had a storehouse, built in 1704, near the fording on the Brandywine—was in 1777, when the commissioners gave Chadds 30 pounds to build a ferry boat. In 1760, his son, Francis, applied for some money to repair the ferry boat. Thus travel was conducted over the Philadelphia Post Road at Chadds Ford in the early days before concrete bridges. There are reports of a poor type of wooden bridge being built about 1830, and a better structure in 1842—a bridge containing a partition. These were succeeded, about 1860, by the one shown in the picture.

How to Correct and Prevent Corrosion of Steel

By T. Arthur Smith

Vice President, Turner Construction Co.

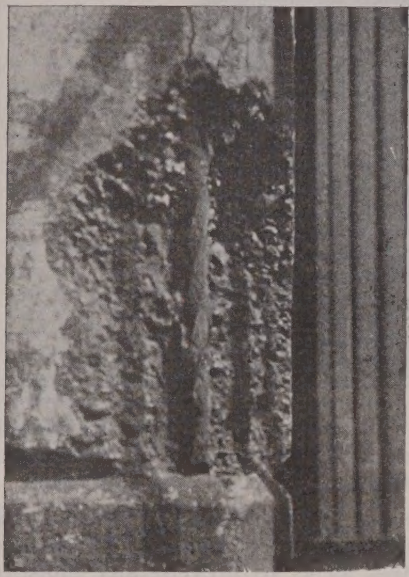


Fig. 1 — Showing Column Bar too Close to Surface

From *Turner Constructor,* a publication issued within and for the "Turner for Concrete" organization.

The evolution of the reinforced concrete building has been very rapid. This type of building is now only about 25 years old, yet it is the recognized standard for industrial buildings. During this period of evolution many improvements both in design and method of construction have been effected.

It is the intention of this article to deal only with the weathering qualities of the exterior face of reinforced concrete buildings. Experience has shown that in order to construct an exterior wall that will withstand the action of the weather successfully it is necessary that the following points be carefully observed:

1. All steel reinforcement must be kept back from the exterior face of all walls and columns at least 2 in.
2. The building in of steel sash, door frames and other miscellaneous steel items must have careful consideration as to detail of recesses, method of anchoring, etc., so that steel members that are left exposed may be placed in such a manner as will permit them to be easily inspected and painted when necessary.

Protection of Steel Reinforcement

Several years ago it was common practice to specify that any steel that was left exposed in order to bond in a future extension, was to be given a brush coat of 1:1 cement grout, in order to prevent these exposed bars from rusting. This belief was held by a great many of the engineers specializing in reinforced concrete construction, and it has only developed in the last few years that a brush coat of grout will not prevent the corrosion of steel bars.

Fig. 1 shows a vertical column bar that has become exposed because of being placed too close to the exterior column form. In this case, moisture penetrated the concrete covering sufficiently to cause the formation of rust on this bar, and the force exerted in the formation of this rust was sufficient to spall off the concrete protection. It is probable that the section of the steel that was attacked by the rust was not more than ½ in. back from the face of the concrete. This protection was not sufficient to prevent moisture from penetrating this covering. Cases have been seen where only a very short length of reinforcement was within ½ in. of the exterior face of the wall or column. Rust has formed on this section of bar, spalling off the concrete and exposing the bar. When a portion of the concrete has been spalled off, exposing a short length of the bar, then the action of the rust on the bar is very rapid. The corrosion will continue down the bar that is exposed, and has been observed to force off a concrete protection of 2½ in. and 3 in.

The reason for this is obvious, as when the initial spalling takes place, there is a little shoulder left at the intersection of the concrete and the bar. Moisture will follow down the bar a short distance, and the formation of the rust will then force off the concrete protection. For this reason, all steel near the faces of walls and columns must be secured in its proper position so that a minimum of 2 in. of concrete protects the steel reinforcement from the action of the weather.

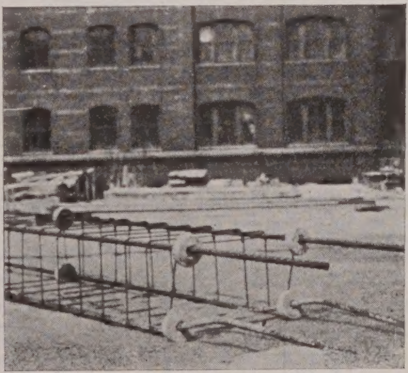


Fig. 2 — Doughnuts on Column Bar Reinforcements

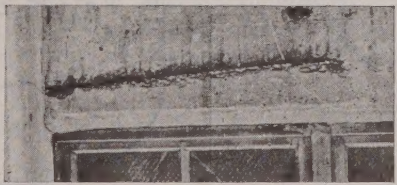


Fig. 3 — Exposed Curtain Wall Reinforcement

Not only does such a condition as this disfigure the building, but if not corrected at once, will in time impair the strength of the building. Our method of protecting the steel from being too close to the ex-

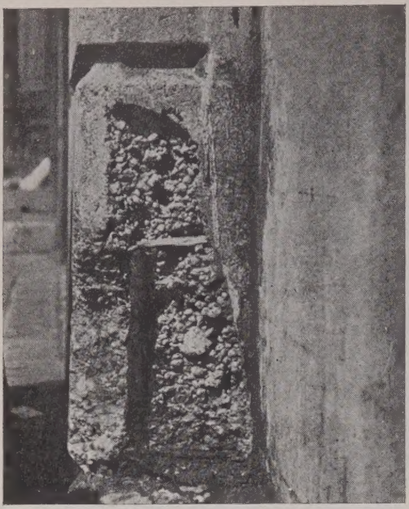


Fig. 4—Exposed Column Reinforcement

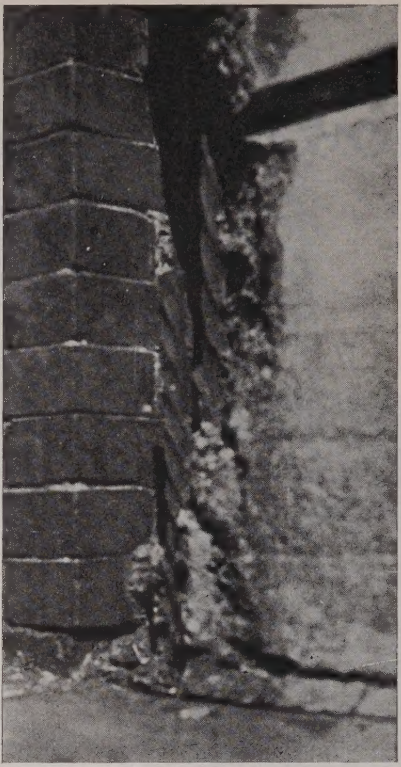


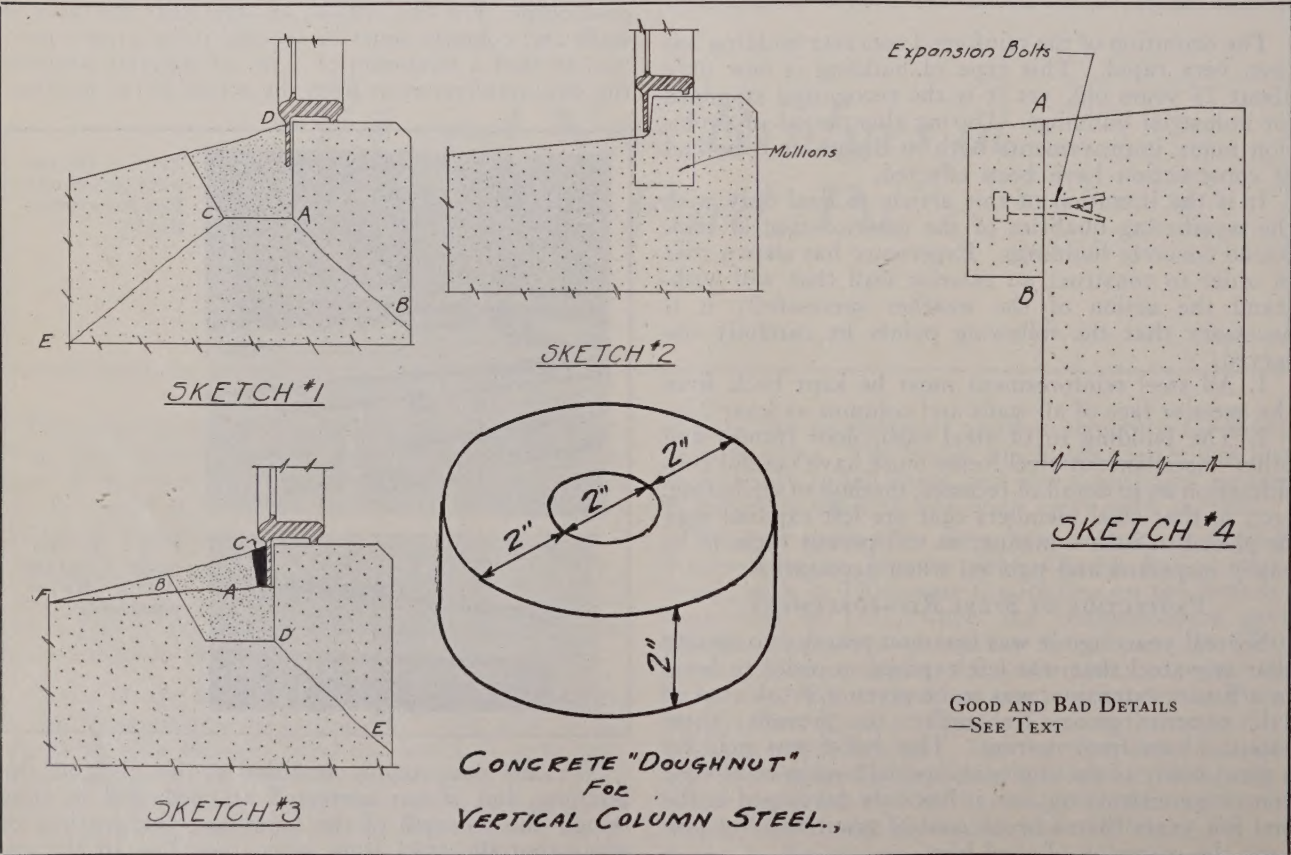
Fig. 5—Exposed Column Reinforcement

terior faces of columns is to place on the vertical column bars, at the time that the column reinforcement is assembled, circular concrete block. These block are made with a hole of sufficient size in the center so that the block can be slipped on the vertical column bar before the hoops have been tied in place. These block are commonly called "doughnuts" (See Fig. 2). It will be noted that the use of these "doughnuts" positively prevents any chance of the column steel becoming displaced, and insures the positive protection of 2 in. of concrete covering protecting the steel.

No spalling has been observed where the reinforcement has been kept back from the face of the concrete 1 in., but in order to make sure, it is considered imperative that weather protection of a minimum thickness of 2 in. should cover all column, beam and wall reinforcement.

A cement wash as an exterior finish is, of course, an added protection, as when it is applied, it is thoroughly rubbed into the face and therefore serves as an excellent weather-proofing agent.

Where a building is not to receive an exterior concrete wash, it is of vital importance that all surfaces be carefully pointed, so as to prevent any moisture from penetrating the face of the concrete and attacking the reinforcement. Careful inspection of all



Good and Bad Details—See Text

exterior surfaces must be made, and any slight honeycombed or porous areas must be pointed very carefully so as to keep any moisture from penetrating the concrete surface.

If the steel is securely held in its proper position, there is no danger of rust forming on the reinforcing bars, and everyone engaged in the construction of reinforced concrete buildings knows that it costs no more to place the steel the right way.

Special emphasis should be given to this matter, as it is a case where "an ounce of prevention is worth a pound of cure."

Protection of Exposed Steel Work

The method of placing exterior steel work, such as steel sash, door frames, angle and channel guards, window grilles, etc., requires careful study as to the type recess to be formed, and consideration must be given to the method of anchoring and building in of these members.

Steel sash have been in general use for only about ten years. Experience shows that not only must the sash be securely grouted in place, but care must also be exercised in embedding any part of the steel sash in the recess left in the concrete. Sketch No. 1 (Fig. 5) shows the method that was used several years ago to secure the bottom of the sash in the sill. This method has been found to be defective because if the sash is not constantly inspected and painted, moisture will attack the vertical leg of the angle at point D. Rust will form on this leg of the angle, and several instances have been noted where the rust thus formed has exerted sufficient force to shear off a section of the sill along the line A-B, leaving the bottom of the sash without anchorage.

In the majority of cases, however, the formation of rust on this member has forced off the portion of the concrete sill that is outside the face of this angle, shearing off the concrete along the line C-E, Sketch No. 1. This latter case is not as serious to the occupants of the building, as the window still remains in its proper position and protects the interior of the building from the cold and rain. It is very serious, however, when the exterior portion of the sill is forced off, as this portion of broken sill often falls to the sidewalk below and is likely to injure a passerby.

This defective detail has been corrected, as shown in Sketch No. 2 (Fig. 6). We have found that this sill detail is superior in every way to No. 1, as sash set in this manner forms a weather-tight intersection with the sill. Should the bottom angle of the sash not be painted and corrosion starts, then the action of the rust will not exert any pressure on the concrete sill, and consequently there is no danger of a portion of the sill being forced off. Further, No. 2 method permits this steel sash to be easily inspected and painted at its most vulnerable point.

When the detail shown in No. 1 has been used, and the rusting of the angle entering the recesses has not progressed very far, then a repair can be made, as is shown in Sketch No. 3. The entire outside face of the embedded angle must be cut clear of the embedding mortar so that there is a space of ½ in. to 1 in. between the face of the angle and the mortar, and then the angle must be cleaned thoroughly of all rust and carefully painted with an approved paint. After this is done, the space "C" must be filled with a mastic, such as Minwax or similar compound. Several repairs have been made in this manner, and inspections have shown that this method has been very effective, and that no further trouble has developed.

Where the slope of the sill will permit, the repair above noted (Sketch No. 3) can be made by cutting the sill down to line A-F; thus giving a detail that is identical with Sketch No. 2.

Corrosion of the steel members that build into the recess at the jambs of the window openings have caused practically no trouble. Several years ago it was common practice merely to point up the jamb recesses. Considerable leakage was observed around jambs that were finished in this way, but no breaking off of the concrete because of the formation of rust on the jamb angle has been observed. For a priod of the past several years all windows have been grouted into the jamb recesses, and practically all leakage at the joint between the window jamb and the concrete has been eliminated.

The building in of steel guards for exterior columns, door openings, platforms, etc., requires that the method of placing be given careful thought so that no moisture can get behind the steel guard. Many instances have been observed where the water has penetrated behind the steel guard, and rust has formed on the back face of the guard. This rust forming on the back face of the guard forces the guard away from the concrete surface, and in many cases has exerted sufficient force to break the anchors tying it into the building.

Another instance that should be mentioned is a case where an ornamental band was added to the top of a parapet wall (see Sketch No. 4). To place this ornament and anchor it to the building, holes were drilled in the top of the parapet and steel expansion bolts placed in them. Then a form for the band was built and the concrete placed. Several years after this work was done, the owners advised that a portion of the parapet wall had broken off and fallen. Fortunately this ornamental band was not over the sidewalk, but was over an adjacent building, consequently nobody was injured. An inspection showed that moisture had entered the joint A-B between the parapet wall and the ornamental band and rust had formed on the expansion bolt. The force exerted by the formation of the rust was sufficient to force the band away from the parapet wall.

Whenever it is necessary to make a repair to the exterior of a building that requires the addition of concrete to the face of a building, care must be taken to see that this is thoroughly done. If it is necessary to use wire mesh or expansion bolts, the mesh and bolts must be of a non-corrosive metal, for if steel mesh or bolts are used, they are very apt to rust and the repair will consequently be only temporary.

Architects and owners should be advised upon the completion of a building, that a careful inspection of the exterior surfaces of their buildings should be made every six months. The painting on exposed steel work should be carefully observed, and the paint coat maintained in first-class condition. If any corrosion of steel reinforcement is noted, the contractor should be immediately notified in order that an inspection may be promptly made and decision reached and recommendations made as to the best method to make this repair. Any delay in making repairs to exterior surfaces is apt to be very costly, as experience has shown that repairs can be made at comparatively small cost if taken in time. "A stitch in time saves nine."

Since a certain small percentage of our older buildings are showing the effects of careless placing of steel, a further discussion of present-day safeguards seems desirable. What methods do you use?—Editors.

Fire-Gutted Building Reclaimed With Concrete

By Grady Triplett

After fire had gutted a three-story brick building in Houston, Texas, concrete was used to transform the smoke-stained shell into a stucco-finished structure which complies with city building regulations. As reclaimed, the building has its walls covered outside and plastered inside with stucco. The floors and roof are concrete slabs, and all beams, columns, and stairways are concrete. Even the old steel beams and columns supporting the front of the building have been encased in concrete.

While the burned structure was three stories, the building is now two stories. L. S. Green, the architect, says the whole three stories could have been reclaimed, had city officials not demanded tearing down the walls, a process that was halted when the architect submitted plans and specifications for saving the walls in a new structure.

A singular situation in regard to the lease made it necessary to get a habitable structure on the site, after the fire, December 18, 1923. The property had been leased for a 10-year period, beginning April, 1924. Owners of the property were in the predicament of canceling this lease, unless a building suitable to the lessee could be provided by April 1. It was considered impossible to tear away the old walls and construct a new building by that date.

As city officials insisted on removing the hazard of the standing walls, the work of tearing them away was in progress, when the Houston architect offered plans for saving the walls and providing an acceptable building in time to hold the on-coming lease valid.

In following the architect's specifications, construction was carried out in the following order: First, the destruction of the old walls was carried on until the old third floor of the building had been removed. Then all debris from the fire was removed.

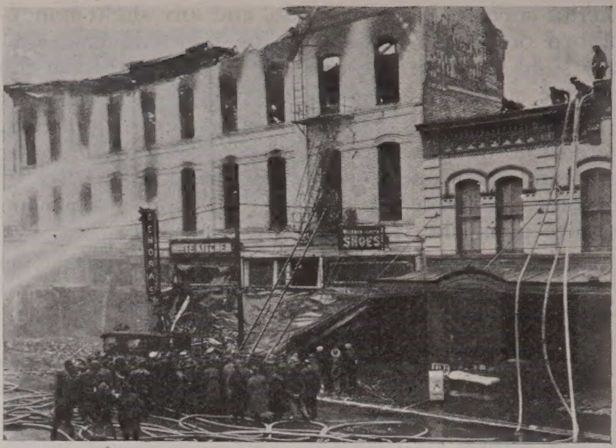
This left the whole brick walls two stories high. The old third floor was only partly destroyed, and the second floor was little damaged. Both these floors with their joists were left to use as forms for pouring the new concrete slab floor and roof for the two-story building. The building had no basement, so the old wooden ground floor was torn out, to permit pouring a concrete floor on the ground.

With the old structure thus prepared, the concrete, columns, beams, and second floor were poured.

Holes were cut in the wooden second floor for the columns and the beams. Under these holes, forms were placed for the columns and beams. Beams were placed at 16-ft. intervals under this floor, running parallel with the narrow dimension of the structure. With these forms just under the old wooden floor, its few damaged places were repaired, so it would serve as the form for pouring the concrete slab floor. Around the building, at the level for the new slab floor, two courses of brick were removed from the walls, to allow the concrete to run into the crevice, and made the walls support a part of the floor load.

The pouring process was one operation for these columns, beams, and the second floor. As the new slab floor was poured on the old floor, this raised the ceiling of the first floor by 15 in., the joists for the wooden floor being 2 x 14 in. with 1-in. floor.

After pouring the columns, beams, and second floor, forms were built for the roof slab, building these from the second floor to the old third-floor level of the burned structure. Considerable repairing was necessary to the old third floor to make it strong enough for a form to support the roof slab. The work followed the process for the second floor, holes being cut for the columns and beams, while brick were removed from the walls to allow the slab roof to take part of its support from the walls. The pouring was one operation, columns and beams being prepared first. The roof was poured, over the old third floor as a form. This raised the roof 15 in., the distance the new concrete floor was above the old first-floor ceiling before the fire.



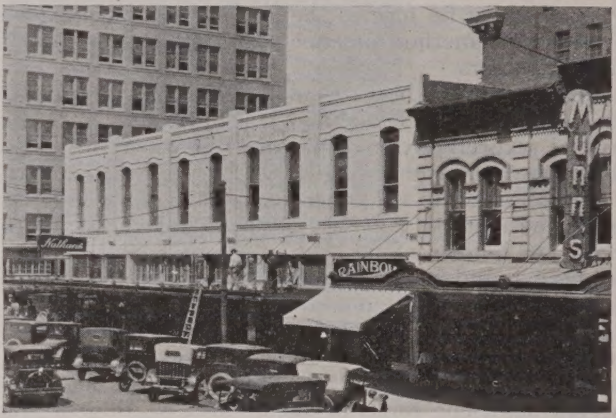


Fig. 1—The Three-Story Building after the Fire

Fig. 2—The Two-Story Building As Reclaimed from the Ruins of the Three-Story Structure by Use of Concrete

When the concrete was hard, the old floors and joists were removed, as other forms are removed, leaving the second floor and roof supported as if they had been poured into a new building.

The old building had store display windows along both fronts, 80 ft. on Main Street and 100 ft. on Capital Avenue. Steel columns and beams supported the walls over these windows. To keep the new construction within the fire code, these steel supports, which had not been damaged by the fire, were encased in concrete, forms being built around them and the concrete poured along with that for the second floor and its supports.

The standing walls had been only slightly damaged in the fire, so they were hacked both inside and out to allow the stucco and the plaster to bond. The walls were given a stucco finish outside and plaster inside.

Even the window frames for the second floor were retained from the damaged structure. Some of these had been damaged, but they could be repaired. On the Main Street and Capital Avenue sides, none of

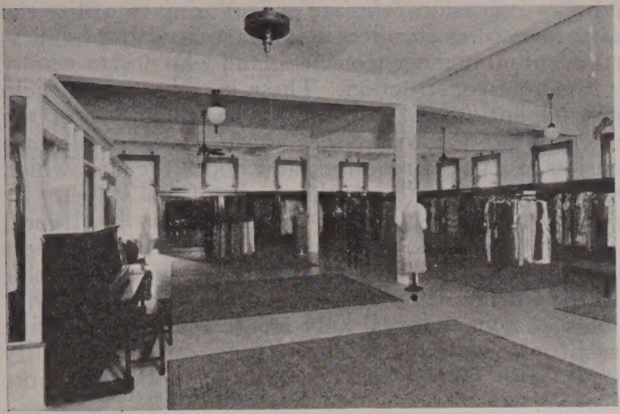


FIG. 3—INTERIOR VIEW SHOWING THE REINFORCED CONCRETE CONSTRUCTION

the window casings was destroyed. Steel window frames were provided for the rear of the building, to comply with the building code.

The slab roof was covered with a composition and gravel. The roof has but little pitch, something favorable to construction in the south Texas territory, according to the architect.

The whole building now has been divided into five stores on the ground floor, while one occupant has the second floor.

The value of this method of reclaiming the old structure can be appreciated from the saving of time and money in providing a building that proved acceptable to those holding the lease to become effective April 1. It required only 60 working days to remove all debris, prepare the walls, and complete the reclaimed structure, and the building was delivered within the time specified. The whole cost was around $45,000. To construct a similar new building would cost between $80,000 and $90,000.

The building, as completed, met every requirement of the city building code for the downtown section of Houston. It is fireproof in every detail, as concrete was also used for all stairways.

It was the second time the architect had used the system for reclaiming a brick building gutted by fire. The other instance, about two years ago, was when a building 47 years old was gutted. He proposed his plan to the owner, who was informed by the city inspectors that no method could repair the structure to comply with the building code.

The architect then drew plans for the work and wrote specifications for completing it. He submitted these to the city officials, and was informed that no fault could be found with it. This building was three stories and in the middle of a block. The three floors were reclaimed, and the work met all code requirements.

According to this architect, concrete is the only material that will allow a building to be reclaimed and left fireproof.

Block-Work in Britain—*The Old Familiar Story Repeated Across the Water*

BY CHARLES MARQUES
ENGLAND

The concrete block is arriving in Great Britain. The housing shortage has given great impetus to the concrete unit and concrete construction generally, but as always with over-anticipated demands, the production became too erratic in system and so variable in quality that only a few good block manufacturers survive, even though housing is still to the fore in the national program and all building proposals suffer from lack or costliness of material.

As usual, every man who could raise sufficient funds to provide himself with a few tools, including a block machine or molds, and a bag of cement or a heap of cinders or gravel, called himself a block manufacturer; and many were able to procure capital enough to start upon what should have been lucrative propositions. All who went into the thing felt that concrete would succeed, but failed to remember that a new thing, especially in an old country, must be thoroughly good to make any headway against the prejudices of those so long accustomed to rely upon what has been done before.

Makers of block machines doubled their works and trebled their outputs; vieing with each other in placing what was always (according to the makers) the most effective, economical, and easily manipulated block producer on the market. In this way they reaped the reward of seeing most of the block business go out of action, for the simple reason that the best machine will not produce good concrete from poor or badly used material. The result is that many block machine makers have shut down, and only a few block makers remain to prove that good concrete units, produced on a commercial basis by first-class methods, of good and understood material, will survive, even though hardily, to propagate the gospel of their fitness in the World of Works.

Cinder or clinker breeze, pit ashes, gasworks refuse, any kind of gravel and sand, became to the owner of a block machine the material from which he would, and did, with very little cement, supply units that entered into the construction of houses that in many cases will condemn concrete while they exist. Much of this work is covered by stucco, or is partition plaster-covered walling. Yet the actual man who built it knows enough to be silent while his employer makes money out of the cheapness that becomes a false economy to the purchaser.

Concrete experts, still pondering the possible formulae of reinforced work, neglect the unit systems. The cement trade, secure in demand for road and reinforced work and requirements, do not, and will not, see the possibilities of the block demand, and it is only those block makers who make anything in concrete, from bricks to high-class art stone, who can impress the architect and engineer of the quality of their works —many of these having inherited the traditions of their fathers to such an extent that their buildings are always mere copies of what have been.

The architect will revel in Roman style, quite forgetting the *opus testaceum*, alias the common clay brick in various shapes, was used as a facing to the concrete which made many of the wonders of Roman architecture possible.

There are architects today who decry concrete work in every form, yet who will stucco a bad brick building with an inch of cement mortar to protect it. They see in every city, town, and village, pathways beautifully level and smooth, of cement concrete paving laid in slabs, and, standing upon it, will question the wear and tear, abrasive, and weather effects upon exposed concrete.

Yet, in spite of this, concrete is coming into its own. The modern maker willing to receive ideas—and to make experiment and research, testing the effects of steam-curing, chemical hardening, water percentages, etc.—will eventually succeed.

Of course there are many architects equal to any and every occasion, who are endeavoring to utilize the advantages concrete offers in its plasticity, adaptability, and eventual homogeneousness, and who design wholly for concrete construction. These men have been held back by antiquated laws or by bad handling of the material, but the writer sees ahead a clearer comprehension of what is required, and hopes for laws which will accept concrete on the basis of its value. At present, a builder may use, instead of clay brickwork, walls of blockwork which are specified by thickness instead of quality. This, so long as the aggregate holds together in the name of concrete, is allowed; and thus a bulk of poor material may create costs of freighting and lifting, while much less material of better quality would save money and labor, and be much more effective.

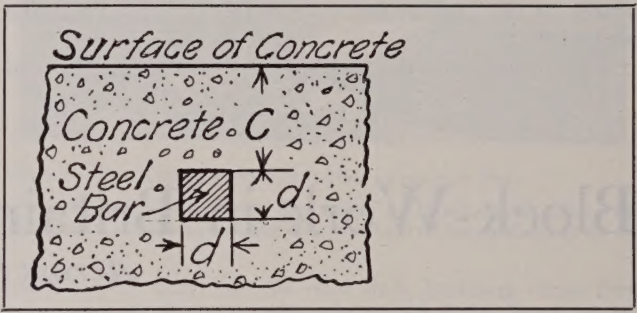
Relation Between Reinforcement Embedment and Size of Bar

In an examination into stresses set up by temperature changes in the surface areas of reinforced concrete, A. S. Woodle, Jr., Engineer of Plant for the Baldwin Locomotive Works, Philadelphia, Pa., states in *Engineering News-Record* that much of the feeling of uncertainty which many engineers have today with regard to the general use of reinforced concrete, particularly on work exposed to the weather, is caused by the unsightly cracks and spalling which are only too frequently seen on structures from 5 to 10 years old. It is stated to be generally recognized that disintegration of this kind is caused by corrosion of the steel reinforcing rods, the iron oxide formed by the corrosion occupying six or seven times as much space as the steel from which it is formed, and thus cracking and pressing out the protecting shell of the concrete. The movement of the bars during the operation of pouring is largely prevented by specifications and inspection which have become more rigid of late years as to the proper placing of the bars in the form and fastening them in place so they cannot move.

Attention is brought to the fact that steel bars, even if originally coated with rust, if kept covered with sound concrete, will not only not corrode further but will be cleaned from the original rust, the iron oxide disappearing, due, probably, to absorption of the oxygen by the lime in the cement, leaving the blue steel. The inference is made that corrosion cannot occur unless the concrete is cracked in some way, thus permitting access of the corroding influence of air and moisture to the steel.

In examining the matter of design covering the location of rods in concrete beams so they will not rust, in the analysis quoted from the article, the writer endeavors to show:

1. That owing to the slight difference between the coefficient of expansion of steel and that of 1:2:4 concrete, there is a force acting under certain temperature conditions against the layer or "bridge" of concrete which protects the steel.
2. That this force is large enough in many cases to break the concrete "bridge" and cause cracks to appear.
3. That the force is a direct function of the dimensions and shape of the reinforcing bar.
4. That it is perfectly practicable to design the concrete protection or "bridge" strong enough to resist the expansive force due to any assumed temperature difference, and thus protect the steel indefinitely as long as the assumed temperature difference is not exceeded.



It should be remarked at this point that this examination is intended to be qualitative in character rather than quantitative. It is not claimed that the mathematical analysis, as far as it goes, is exact. The whole purpose has been to brng out and state a reason for the fact that the cover of concrete over a steel rod is a direct function of the size of the rod, and that a cover which will adequately protect a sheet of expanded metal, for example, cannot be expected to protect a 6-in. I-beam.

In proceeding with the analysis, the following assumptions are made:

1. Coefficient of expansion of steel	0.000006
Coefficient of expansion of concrete	0.0000055
and therefore excess of steel over concrete =	0.0000005
2. Outside temperature difference	100° F.
3. Temperature difference inside the concrete at a point near the surface	50° F.

We may also assume that the bar of steel is sufficiently close to the surface of the concrete, and the body of the concrete sufficiently thick, so that the entire effect of the swelling of the steel due to temperature would be toward the near surface.

Now consider a steel bar *d* in inches square with an amount of embedment (i. e. the distance of the steel from the surface of the concrete) to be *c* inches, as shown in diagram.

Then for the given temperature difference (50°), we may design the embedment *c* so that the deflection in the small concrete "bridge" over the steel bar will not be sufficient to cause more than a safe tensile stress in the concrete.

The concrete "bridge" can be considered as a beam with supported ends, of depth c and unit width, with a uniformly distributed load of W lb.

Then the deflection y, due to the load W, will be $\frac{5\,Wd^3}{384\,EI}$

If for E modulus of elasticity we use 2,000,000, and for I moment of inertia we use $\frac{c^3}{12}$ we have the equation

$$y = \frac{5Wd^3}{64{,}000{,}000c^3}$$

We also have for the deformation on account of temperature difference

$$y = 0.0000005 \times 50 \times d.$$

Equating the two values of y

$$\frac{5Wd^3}{64{,}000{,}000c^3} = 0.0000005 \times 50 \times d$$

or

$$W = \frac{320c^3}{d^2} = \text{amount of load.}$$

The maximum fiber stress in concrete beam due to load $W = \frac{M}{S}$

where M = bending moment $= \frac{Wd}{8}$

and S = section modulus $= \frac{c^2.}{6}$

$$\text{Therefore the fiber stress} = \frac{320c^3 \times d}{d^2 \times 8} \times \frac{6}{c^2} = \frac{240c}{d}$$

and if we put down 240 as the fiber stress, we have $c = d$. In practical design a factor of safety of say 2 would be recommended; that is, make $c = 2d$.

In the case of a round bar, conditions would be somewhat different, as the loading of the "bridge," which in this case would be arch shaped, would be of a fluid character, that is, normal to the intrados of the "arch" on purely radial lines, and the exact analysis would develop a different set of equations, but it can readily be seen that the worst case is that of the square rod, so that there appears to be no need of going into the case of the round rod in any detail.

In view of the analysis so far made, the following conclusions are not unreasonable.

The amount of security against cracking of a concrete surface, due to corrosion of the reinforcing bars, varies directly as the diameter or square size of the rod.

The amount of embedment required varies directly as the diameter or square size of the rod. These calculations corroborated by experience having shown that 2 in. of cover over a 1-in. rod, or ¼ in. cover over a ⅛-in. wire, is needed to protect the steel. It is felt that this fact should be recognized and covered in greater detail than is now the case in standard specifications.

The October issue of this magazine will celebrate 100 years of Portland Cement.

Crazing

A Study of Its Causes and Prevention

To find the causes and prevention of crazing or hair checking is to be the work of a new committee of the American Concrete Institute, with P. H. Bates, of the United States Bureau of Standards, as chairman.

As crazing is at least a disfiguring manifestation on some concrete surfaces, the means to its avoidance have been studied by manufacturers of concrete building units, stucco workers, producers of ornamental concrete and others. A brief discussion, recently published in *Contractor's Atlas*, is as follows:

> Every one interested in concrete work has noticed the presence in some types of concrete work, of small hair checks on the surface. Sometimes these checks are called "map-cracks," but this is somewhat of a misnomer, because, in a sense, they are really not cracks, for they extend only a very short distance into the surface and do not affect the integrity of the concrete unless they become larger through the action of the elements.
>
> Many theories have been advanced as to the cause for this defect in concrete and stucco surfaces. Most experienced workers in concrete attribute the checking to one or more of several causes—first: an improper or too rich mixture; second: the use of a fine aggregate having too great a proportion of very fine material; third: allowing the concrete or stucco to dry out too rapidly; and fourth: an excessive troweling or working of the surface. These are all contributing causes to the presence of a very rich film of cement on the surface of the concrete or stucco, and it is in this film of rich, fine material that the checking occurs.
>
> A theoretical explanation might be that the rich film has a different rate of expansion and contraction than the leaner concrete lying under it, and this causes the checking. We often see a very similar checking in white glazed clay wall-tile. We do know that rarely if ever can checking be found in concrete or stucco where the surface film has been removed by tooling, scrubbing, or acid washing.
>
> Conclusion: It would seem, therefore, that the best preventive for hair checking is proper curing and the elimination, as far as possible, of the rich surface film. This elimination may be secured by better selection of the aggregates, less troweling and, wherever possible, the rubbing, tooling or washing of the surface.

With the foregoing, not everyone will agree in all particulars.

Producers of very high quality concrete stone say that crazing occasionally, though rarely, will manifest itself even in the new surface exposed by tool dressing.

Others in the same general line of work say that the avoidance of rich and excessively fine mixtures on the surface and the employment of slow curing methods will prevent crazing.

Still others insist that these methods will give satisfactory results 99 times, and crazing will appear the 100th time under conditions *seemingly* identical with the 99. Like conditions always produce like results. Obviously there is some factor in the conditions not under perfect control or observation.

Until the new committee finds the answer, the surest escape is in the use of those textured surfaces in which crazing is less prone to develop and when it does develop, is not noticeable.

F. W. Ives

When rather tardy notice was published in the August issue of CONCRETE of the election of F. W. Ives to the presidency of the American Society of Agricultural Engineers, CONCRETE was not aware of the death of Professor Ives in a railroad wreck at Buda, Ill., June 30.

Efflorescence or "Bloom"—*Its Causes, Prevention and Removal*

Efflorescence presents a problem not entirely solved on which research is needed. It is no more a problem of concrete than of other masonry, but, as in many other directions, the concrete experts are more active to clear up the difficulty.

CONCRETE is able to publish two discussions of the subject which at least serve to get the matter pretty thoroughly on record, and they may supply a basis for further study. Says one authority:

Efflorescence appears as a white, crystalline incrustation which usually proves to be pure calcium carbonate, although magnesium carbonate, silicate of lime, and calcium sulfate have been found in exceptional cases. It may be significant that all are magnesium or calcium salts. The usual explanation of efflorescence is that calcium hydrate (or one of the other soluble magnesium or calcium salts mentioned) is brought to the surface of the concrete in a water solution, where during the evaporation of the water, the hydrate reacts with the carbon dioxide or carbonic acid in the air, forming insoluble calcium (or magnesium) carbonate.

Efflorescence is noted, particularly in the spring time, on masonry of almost every kind; it is not a blemish peculiar to concrete. Joints laid up with lime mortar are a common source of efflorescence, even when masonry units themselves produce none. Over 60% of the masonry residences in one of the most exclusive sections of Chicago showed more or less efflorescence in early April. Both old and new masonry were affected. Similar conditions were found in a number of other cities, and further investigation undoubtedly would show that they are very general.

As might be expected, efflorescence appears only after the presence of moisture. The usual damp conditions in the spring, coupled with a lower rate of evaporation, give moisture a better chance to penetrate masonry than at other seasons. During the summer, rain evaporates so quickly that it does not penetrate concrete as deeply as in fall and spring. The smaller quantities of moisture, near the surface of the masonry, dry off more quickly.

Efflorescence is found in greatest quantities within 2 ft. of the ground level, underneath projecting horizontal surfaces, such as cornices, eaves, and sills, and where joints have opened up for any reason. It disappears to a great extent during warm weather, but often only to reappear the following spring.

Although close inspection will reveal that efflorescence is present on concrete in a very large proportion of cases investigated, it is seldom of any consequence, except where the appearance of the surface is a consideration. The prevention of efflorescence is especially important in whatever building material—clay, concrete, or stone—if of a color or of a fine exterior finish on which it becomes an unsightly blemish. In the concrete field, it is an occasional annoyance to producers of floor and roof tile and face brick and block. Efforts to overcome the difficulty are only partially successful.

In concrete products, efflorescence usually becomes evident during or directly after the curing period, and may recur upon subsequent exposure to moisture, particularly when exposed to cold or cool weather. Some roof tile manufacturers find that it frequently (and one large producer says *almost always*) disappears after a short exposure to the weather.

Even quite dense concrete sometimes shows light efflorescence. A slight amount of efflorescence in the minute surface pores of dense concrete tends to lighten color by dilution of the pigments. Very thin coatings of efflorescence on the surface are brought out boldly by a strong color background. The apparent fading which results is seldom uniform. The amount of efflorescence diminishes as density of concrete increases, but it is important that even minute quantities be eliminated in such products as floor tile, wainscoting slabs, stair treads and face brick. Another factor to be considered is that even though denser, concrete which has a high cement content has more of the soluble salts which seem to be the primary cause of efflorescence in concrete.

Rough-textured surfaces, exposing light-colored aggregates, conceal a considerable quantity of efflorescence. For that reason, many manufacturers have specialized in concrete face brick and architectural stone of light shades which require a heavy coating of efflorescence to become even noticeable, and quite excessive quantities to appear unattractive.

MATERIALS AND GRADING

Observations show no appreciable difference in the amount of efflorescence due to the character of particles in aggregates. The nature of sand is such that in its formation, soluble materials usually are washed out. It was expected that concrete, using limestone screenings as aggregate, might show increased efflorescence due to probable soluble lime in it, but no difference has been observed at various plants between concrete made with gravel and that made with limestone aggregate.

Grading of the aggregates has a direct effect on density and absorption, and therefore on efflorescence. In general, aggregates containing particles occupying the entire range from fine to the coarsest size which may be employed, may be expected to give the best results. Many concrete products manufacturers purchase graded aggregates, and can, by insisting upon it, obtain a more uniform and better grading with this consideration in view. Although the maximum size of aggregate which can be used in floor tile, roofing tile, and brick is small, improvement can be made in the grading for these and other products for which relatively fine material is used.

MIXING

Both time of mixing and period between mixing and molding concrete may influence efflorescence. Available data on these points are inconclusive, and it is practically impossible to study the effect of these manipulations by plant inspection.

CURING

Curing methods unquestionably have a very important bearing on efflorescence. Slow curing at moderate temperature uniformly maintained, with moisture controlled rigidly at an amount just sufficient to prevent drying of concrete, reduces tendency to efflorescence.

Curing outdoors by sprinkling frequently is attended by heavy efflorescence. In such cases, it seems likely that moisture is intermittently added to and drawn from the concrete. Products which have been cured inside often show efflorescence after a period of yard storage. Rain and humidity at night add moisture which dries out in the warmer temperature during the day.

Chemical Treatment

Intermittent experiments have been carried on at various places to overcome efflorescence in concrete by means of chemical admixtures or surface treatments. Although some of these methods have shown promise, they have not been studied sufficiently to justify any general conclusions.

Conclusion

By the careful application of the most favorable conditions of gradation, consistency, compacting, and curing, much can be done in the manufacturing process to lessen efflorescence. Attention to these four factors will probably always constitute the first requirements for the avoidance of this difficulty.

Gradation of aggregates should be designed to give maximum density.

Consistency should be maintained absolutely uniform, using minimum amount of water with which high density can be secured.

Compacting, whether done by pressure or tamping method, should be thorough and uniform throughout the mass.

Curing should be rigidly controlled at uniform moderate temperature, with moisture just sufficient to prevent drying of the concrete.

With these factors given full consideration, and other manufacturing conditions maintained as near ideal as possible, efflorescence can be greatly reduced if not entirely overcome. The great value of a positive chemical fixing agent, if found, cannot be underrated; but obviously, such a treatment must be looked upon as an adjunct to, rather than a substitute for, the practice prescribed above.

Another student of the subject, writing in *Contractors' Atlas* (Atlas Portland Cement Co.), disagrees with the roof tile manufacturer who finds that efflorescence washes off when left alone. He raises the question: "Why doesn't the white deposit dissolve and wash off in the next rain?" The reason is that upon exposure to the air, these salts change their nature, absorbing carbon dioxide from the air and becoming carbonates, and hence largely insoluble in water.

From the explanation of the action of efflorescence, it will be apparent that the presence or absence of efflorescence is mainly due to local conditions, such as the amount of absorption of the masonry material, the degree of exposure to rain-water, drippings, and drainage, rather than to any factor inherent in the mortar or masonry material.

Remedy for Efflorescence

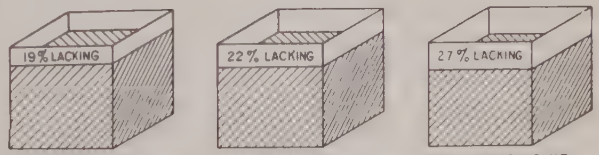
The same writer suggests remedies:

Since the absorption and evaporation of surface water is the primary cause for efflorescence, anything which will eliminate this absorption will aid in preventing efflorescence. The application of one of the colorless waterproofing compounds to the surface of the wall will eliminate absorption, and hence be of help. Among these materials might be mentioned sodium silicate (water-glass) and magnesium fluosilicate as surface applications to concrete and stucco surfaces. Colorless surface applications of the dissolved paraffin type also should be beneficial for application to brick and stone walls. For efflorescence already existent, the only remedies are brushing with a stiff fibre or wire brush, or the removal by scrubbing with an acid wash consisting of 1 part of commercial muriatic acid and from 4 to 10 parts of water, depending upon the amount of efflorescence present. After the white deposit is removed with the acid wash, the acid is thoroughly rinsed off. The deposits may recur and require additional acid washes, but the amount of deposit should be less each time, due to the dissolving of all the soluble salts, and hence the deposit should disappear after a time.

The Bulking of Moist Sands—*Effect on Strength and Yield of Concrete*

From a paper by Arthur A. Levison, Highway Engineer U. S. Bureau of Public Roads, in *Public Roads*.

When dry sand is moistened by mixing with a moderate amount of water, the volume of the sand is increased out of all proportion to the amount of water added. Stated otherwise, dry sand weighs more per cubic foot than moist sand. While this bulking or swelling phenomenon was recognized and investigated more than 30 years ago, the direct effect of it on the measurement of fine aggregates for concrete has attracted attention only recently. The Iowa State Highway Commission, for example, experimented in 1923 with the weighing of aggregates for concrete road construction, and, as a result of the experiment, has adopted the practice of weighing as standard procedure. One of the advantages claimed for the weighing method is that the effect of moisture on the volume of fine aggregates can be disregarded, the only correction necessary being that for the weight of contained water. The inundation of sands has also been advocated as a means of measuring accurately under almost constant conditions the amount of sand and water for each batch of concrete.



POTOMAC RIVER CONCRETE SAND ALLEGHENEY RIVER CONCRETE SAND POTOMAC RIVER ASPHALT

Fig. 1

Experiments made recently by the United States Bureau of Public Roads show that the extent to which a given sand will bulk is dependent principally upon its nature and gradation, the manipulation, and the amount of moisture present. In general, fine sands bulk more than coarse sands. Fig. 1 shows the shrinkage of three widely different sands, the volume of which measured in a condition of maximum bulking was 1 cu.

PERCENTAGES RETAINED ON STANDARD SIEVES	SAND "C" POTOMAC RIVER CONCRETE SAND	SAND "M" ALLEGHENY RIVER CONCRETE SAND	SAND "F" POTOMAC RIVER ASPHALT SAND
¼ INCH	1	0	0
NO 10	48	13	1
NO. 20	70	24	7
NO 30	79	48	19
NO. 40	83	68	31
NO. 50	88	89	49
NO 80	93	97	70
NO. 100	95	98	82
NO. 200	97	99	92
PASSING NO 200	3	0.8	8

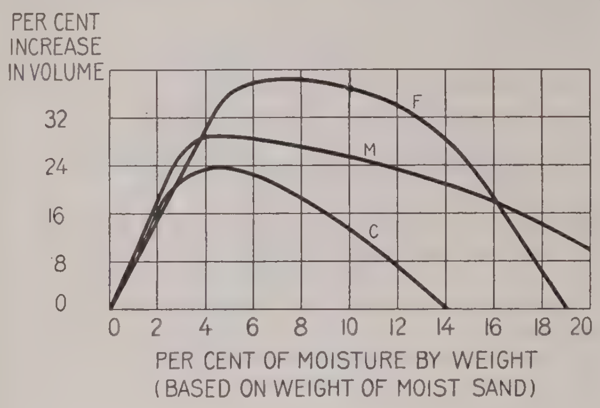


Fig. 2

ft. It is apparent that volumetric measurements of concrete sands under certain moisture conditions will give approximately 20% less of actual sand than the same volumes of the sand when measured in a dry condition.

Bulking Amounting to More Than 25% Possible With Ordinary Moist Sand

The relation between increase in volume and percentage of moisture is shown by the curves in Fig. 2, from which it is evident that the rate of change of bulking is most rapid for moisture contents up to 3 or 4%. Sands used for concrete construction are almost never dry, and 3% of moisture constitutes a barely damp condition. Even with 6% of moisture, there is no visible evidence of free water. On a 20-mile concrete paving job in Iowa where the aggregates were weighed, moisture determinations made several times each day showed that the moisture content of the sand ranged from 3 to 6% with by far the majority of the determinations lying between 4 and 5%. If the conditions on the Iowa job are at all representative, it will be apparent that for sands C and M, laboratory bulking factors of 22 and 28% respectively, will be sufficiently accurate for moisture contents between 3 and 6%. Another interesting fact evidenced by the bulking curves is that it was possible with sands C and F to incorporate sufficient water to bring the sands back to an equivalent of the dry bulk. In the case of sand M this could not be done by the methods adopted.

A standard slump cone was supported in an inverted position so that its bottom was 12 in. above the top of a ½ cu. ft. metal container. A weighing scale, shovels, scoops, and an oven or some convenient means of drying small samples of wet sand completed the necessary equipment. The first step in a test was to determine the weight of ½ cu. ft. of the dry sand when poured through the slump cone into the container without tamping. About 2 cu. ft. of dry sand was spread on a concrete floor, and, beginning with a small amount of water, successive increments were added so as to raise the moisture content of the sand by steps of approximately 1%. After each increment of water, the sand was thoroughly mixed and agitated with shovels until the moisture was uniformly distributed throughout the pile. When each increment of moisture had been thoroughly incorporated, a representative sample of moist sand was taken to be weighed and dried for determination of the percentage of moisture based on the weight of the moist sand, and two or more determinations of the weight per ½ cu. ft. were made. This latter operation was performed after dropping the moist sand through the cone until the container overflowed, the excess being struck off with a straightedge. The entire process was repeated until the sand became saturated and water began to drain off the pile. The computation for bulking was made on a weight basis by deducting the weight of water from the weight of ½ cu. ft. of moist sand and finding the difference between this weight and that of ½ cu. ft. of the dry sand. Dividing this difference by the weight of dry sand in ½ cu. ft. of moist sand, the percentage of bulking was obtained.

Laboratory Tests Closely Checked by Field Experiments

The effect of moisture on the volume of sand having been determined in the laboratory, the question arose as to what amount of bulking actually took place in the field on a construction job. For the purpose of obtaining this information, experiments were conducted with a modern concrete proportioning plant consisting of steel bins and adjustable measuring batchers with the constant strike-off feature.[1]

The measuring batcher was first calibrated for capacity at various settings of the adjustable feature with dry sand, the capacities being based on the weights of dry sand contained in the batcher. Normal stock pile sand was then loaded into the bin, and, with the batcher set for a known cubical capacity as determined by the calibration test, it was loaded with the moist sand, and the contents was then dumped and weighed. Deducting the weight of the water, the resultant amount of dry sand in a known volume was found. From this

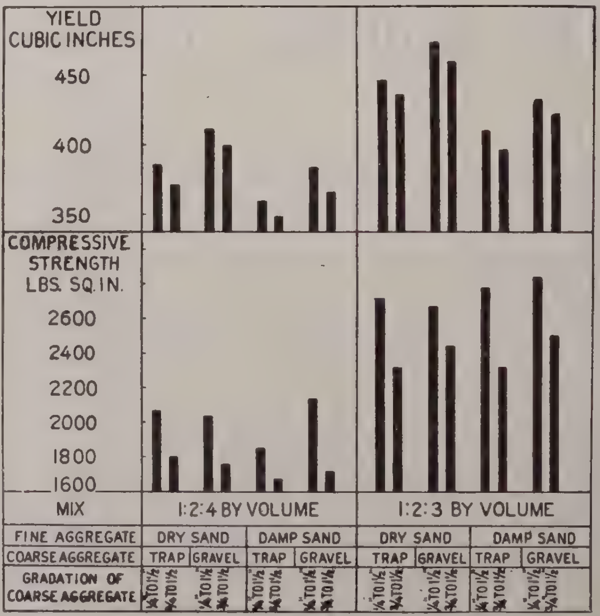


Fig. 3

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[1] This work was made possible through the courtesy and cooperation of the Blaw-Knox Co., of Pittsburgh, Pa.

the bulking of the sand under plant conditions was computed. Incidentally, it was also found possible to compute the required setting of the adjustable batcher which would give a capacity of moist sand equivalent in weight to the original capacity in dry sand. The above-described work was done with Allegheny River sand, designated as M in Fig. 2, and the bulking under field conditions was found to be 3 % less than that in the laboratory. The normal condition of the stock pile sand was 5.5% moisture content. Owing to the fact that the experimental work was done during February and March and that the plant was out of doors, it was not found practical to reduce the moisture content below this percentage. Field experiments were made with moisture contents greater than 5.5% up to a maximum of 9%, and for this range the amount of bulking did not vary any more than is shown by the bulking curves in Fig. 2.

The Effect of Bulking on Yield and Strength of Concrete

It is well known that nearly all of our laboratory tests, investigations, and research on concrete have been based on mixtures with dry sand, while in practice on construction a dry sand is seldom available. Assuming that a 1:2:4 mix is under consideration, the laboratory bases its findings on the true mix with dry materials, whereas on the job it is quite probable that the mix approximates more nearly 1:1.6:4. As a result of this, the field concrete will have a richer mortar than intended, but there may be a deficiency of mortar which will affect both the workability and density of the concrete. If the workability is impaired, the tendency is to use more mixing water, and thus the greater richness of the mortar may be offset to some extent at least. It follows, therefore, that a deficiency of mortar may have a direct effect on the strength and yield of concrete.

For the purpose of studying the effect on yield and strength, ninety-six 6 x 12-in. concrete cylinders were made and tested. The gradation of coarse aggregates was introduced as an additional variable in order to learn its effect also. The fine aggregate was Potomac River sand, and where damp sand was used it contained 6% of water by weight. The materials were proportioned by volume under uniform conditions. The consistency was kept as constant as possible by the use of flow table measurements for each cylinder, in addition to measuring the amount of mixing water beforehand.

The cylinders were made in sets of 16 on six different days, a complete series being cast each day. The operators doing the mixing and molding were changed from day to day, so as not to carry any one personal equation throughout the work. It was found that the measurements for yield and the results of the compressive strength tests showed substantially the same trend for each set of 16 cylinders. The average results of the tests on the 96 cylinders are shown in Fig. 3.

Conclusions

The test results recorded in Fig. 3 form the basis for the following definite conclusions:

1. With gravel concrete the yield per unit volume of coarse aggregate exceeds that with trap rock by about 6%.
2. The decrease in yield due to the omission of coarse aggregate between ¼ and ¾ in. in size is from 3 to 4%.
3. The decrease in yield due to using the nominal volume of damp sand without a correction for bulking is 7% for a 1:2:4 mix and 8½% for a 1:2:3 mix.
4. The decrease in yield due to using damp sand without a bulking correction and omitting the smaller sizes of coarse aggregate is 12%.
5. For a 1:2:4 mix, the mixes made with dry sand averaged 14% stronger than those made with the same volumes of damp sand. For a 1:2:3 mix, the mixes made with dry sand averaged 3% weaker than those made with the same volumes of damp sand.
6. The omission of the smaller sizes of coarse aggregate resulted in a decrease in strength of from 12 to 14%.
7. With a 1:2:4 mix, the cylinders made with dry sand and well-graded coarse aggregate averaged 17% stronger than those made with damp sand and poorly graded coarse aggregate. With a 1:2:3 mix, this difference in strength was 12% in the same direction.

It should be borne in mind that the above conclusions are based on laboratory specimens only, and can not as yet be interpreted to apply directly to field conditions. In fact, it is not the intention of this article to advocate the practice of making a volumetric correction for the bulking of sand on the job until it has been demonstrated that the scheme for making the correction is practicable, also that as a result, the concrete is more economical and at least as strong as under present practice. It is thought, however, that the additional sand introduced into the mix, where an adjustment is made for bulking, may tend to improve the workability of the concrete and thus assist in maintaining a uniform consistency. All of these possibilities are yet to be demonstrated under actual construction conditions.

Circular on Inspection of Portland Cement

With the growing demand for the inspection of structural materials there has been an increase in the number of inquiries received at the Bureau of Standards as to proper methods for carrying out the inspection of portland cement. Much has been written about the inspection of portland cement, but it appears that there is a real need for a paper dealing more fully with the work from an inspection viewpoint. Based upon the experience of the Bureau in caring for Government purchases of cement, John R. Dwyer and Roy N. Young of the cement section have prepared a paper entitled "Inspection of Portland Cement." Often an inspector who is familiar with the various mill processes involved and the routine of inspection is called upon to make a decision which has no precedent in his experience. It is not intended that this paper shall be so far reaching as to be of assistance in all such cases, but during long experience in this work at widely scattered points certain procedures of inspection as outlined have been demonstrated as being the most effective in avoiding complications and in holding the confidence and respect of all parties to the transaction.

This paper was published as two articles appearing in the August and September, 1923, issues of Concrete, However, to give it further circulation and to care for the many inquiries, the Bureau has prepared it as a mimeograph circular and copies may be obtained upon request. It is hoped that the information it contains will be of assistance in conducting true inspection of cement.

A. C. I. Convention

The 21st Annual Convention of the American Concrete Institute will be held in Chicago, February 24-27, 1925.

Light Weight Structural Tile

Concrete block, (commonly the 8 x 8 x 16 unit with which the industry is familiar) will probably be cut down in weight, if not in size, as rapidly as our manufacturing processes become more exact and our control of the quality of our concrete becomes more constant. When that time comes, lighter sections of concrete will be found adequate for our building requirements.

The greatest objection to the standard block is its weight. A mason must ordinarily put down his trowel to lay it. In laying up face units the extra care of two-handed mason work can be justified by the niceties of the result as with cut stone, but by far the biggest part of the block output is not of that kind. When a block is in place, it has displaced about 14 brick, but a one-hand unit of less size and weight and displacing usually only six brick has become very popular.

The light-weight concrete building tile and the units made of light-weight aggregates—cinders or slag—have come to play an important part in the building field.

The building unit of every description must—these days in particular—pass a final test of labor economy on the job.

There is no early likelihood that concrete block will be crowded off the building map, because there are too many different uses to serve and too much difference of opinion among builders to establish any one kind of unit to the exclusion of everything else. The light-weight structural tile has, however, come to fill a very important place, and such units should be considered in all plans for concrete building unit manufacturing enterprises.

A survey of the uses of light-weight tile, of types available, and of manufacturing possibilities has been made by the Portland Cement Association, and a report of this is presented in its more important essentials as follows:

Light-weight tile is usually made in 5 x 8 x 12 in. size with very large air spaces, usually 50%. The tile usually weighs 19 to 20 lb., replaces 6 or 7 brick in the wall, and is designed with hand holes in the top so that a mason can easily handle it with one hand and lay it without dropping his trowel. The greatest saving in the tile is through the increased efficiency of laying. With a little training, a mason can lay very much more wall in a day with tile than with any other unit. Special units are made, such as quarters and halves and right- and left-hand jamb tile. The methods of machine tamping and steam curing produce a strong, dense tile that meets A. C. I. requirements of 1000 lb. per sq. in. in compression and 10% absorption. The 5 x 8 x 12 tile is a multiple of brick sizes, and can be used in practically every form of building construction.

The light-weight tile has the largest range of uses of any concrete building unit. It is admirably adapted for stucco work, for back-up, curtain and partition walls. It can be used without brick facing or stucco for warehouse, factories and farm building construction.

Light-weight concrete building tile have met with success nearly everywhere they have been used. The most striking example that has come to our attention so far is the result of a large industrial housing of the Studebaker Corporation at South Bend, Ind., in which complete cost data wete kept on four types of construction; brick veneer, frame, stucco on wood lath and stucco on concrete tile. The result, as stated in a letter recently received from the Studebaker Corporation, showed that stuccoed houses built of light-weight concrete building tile, had an initial cost lower than frame houses built from the same floor plans.

A new plant operated by the Overlook Development in a suburb of Washington, D. C., is making tile for a housing project there, and is meeting with very good success. Some tile are also being sold to outside trade. A Cleveland firm is making and selling large quantities to builders.

The advantages of light-weight building tile may be summed up as follows: Saving in material (nearly twice as much air space), better insulated walls, easier laid, lighter to ship and cheaper than block.

The following concerns make machinery for the manufacture of light-weight concrete building tile:

Besser Sales Co.
305 Monadnock Block
Chicago, Ill.

Benfer Concrete Machine Co.
Engineers' Building
Cleveland, Ohio.

Blystone Manufacturing Co.
Cambridge Springs, Pa.

W. E. Dunn Manufacturing Co.
Holland, Mich.

Eberling Machinery Co.
2394 Canal Road
Cleveland, Ohio.

Federal Machine Products Co.
2777 63rd Street
Cleveland, Ohio.

W. E. Mouck

Santa Barbara Unit Brick & Tile Co.
Santa Barbara, Cal.

The Allen-Osborn Co.
Rose Building
Cleveland, Ohio.

Ericson Concrete Products Co.
Waseca, Minn.

Provision should be made for adequate curing and power operated equipment. It is difficult and unsatisfactory to cure concrete products properly in the open. Curing rooms should be built in any climate and steam or fog sprays used. Hand-operated machines rarely produce uniformly good products, and certainly are less economical if quality products are to be manufactured in quantity.

COST OF PLANT INSTALLATION

A typical estimate of the cost of establishing a concrete building tile plant with a production of 2000, 5 x 8 x 12 tile per day shows the following costs. The costs will vary according to the type of machine selected and rate of production desired—and must be corrected in each locality for special local conditions, the figures are approximate:

One machine	$3,500.00
3500 pallets, 30 ¢ each	1,050.00
50 cars, $40 each	2,000.00
Two transfer cars, $50 each	100.00
One mixer (9 cu. ft.)	275.00
One loader	200.00
One motor (5 horse power)	500.00
Narrow gauge industrial track	500.00
Freight on equipment	300.00
Installing equipment	1,000.00
Buildings, offices and sheds	2,500.00
Curing equipment, including boiler and piping	500.00
Three curing tunnels, each 90 ft. x 9 ft.	3,000.00
Storage bins	500.00
Contingencies and sundries	1,500.00
Total investment, exclusive of land and working capital	$17,425.00

A plant for producing building tile of the size described is rated to produce 3500 tile per day, but such an output as this can only be obtained under the most favorable conditions, and is rarely kept up for very long. Costs should be reckoned on an estimated production of 500,000 tile per annum, thus giving an average of 2000 per day for 250 days. When the plant has been established, this rate ought to be exceeded, and the cost of production thereby reduced as much as 30%, but it is wiser to figure more conservatively in a new enterprise.

On the basis of 2000 tile per day, in a plant operated 250 days in a year, production costs should be figured as in the following typical example, correction being made for the actual cost of local materials and labor:

DIRECT COST OF 1,000 TILE

Material	9 bbls. of cement, price assumed to be $2.50 per bbl.	$22.50
	5½ cu. yds. aggregate at $2.00 per cu. yd.	11.00
Labor	2 men, 4 hrs. each = 8 hrs. at 50 ¢ per hr.	4.00
	4 men, 4 hrs. each = 16 hrs. at 40 ¢ per hr.	6.40
Liability insurance, water, fuel, power, oil and miscellaneous supplies		1.50
	Total direct cost per thousand	$45.40

OVERHEAD EXPENSE PER ANNUM

Superintendent's salary	$2,500.00	
Depreciation and maintenance on equipment, 30% on $9,425.00	2,827.50	
Depreciation and maintenance on buildings, 10% on $6,000.00	600.00	
Taxes, fire insurance, etc.	300.00	
Contingencies and sundries	1,000.00	
Total overhead for 500,000 tile	$7,227.50	
Overhead cost per thousand		$14.46
Total manufacturing cost per thousand		$59.86

Note that depreciation and maintenance is figured very high, owing to the fact that machinery is still in process of development and improvements that may render existing machines obsolete are likely to be made. As at present constructed, many of the working parts require frequent repair or renewal.

The selling price of the tile will vary according to the selling price of competing materials, but will probably find a market at about $100 per M. On a 500,000 output at $60.00 per M, this will leave a margin of $40.00 per M, or a total of $20,000 per annum to cover advertising and selling expense, loading and delivery charges, interest on investment and on loans, and profit.

In order to prove the economy of the tile, the following method of calculation is presented. It should be corrected for local prices in each locality. Figures are given for 100 sq. ft. of wall, 8 in. and 12 in. thick, laid in portland cement mortar, exclusive of staging, cleaning down, etc.

A. Cost of 100 sq. ft., 8-in. brick wall (equal to 66 2/3 cu. ft.)

1,400 brick at $14.00 per M	$19.60	
21 cu. ft. mortar at .34	7.14	
Labor (800 bricks per day)		
Masons, 14 hrs. at $1.00	14.00	
Tenders, 14 hrs. at .50	7.00	
Total cost per 100 sq. ft.		$47.74
Cost per sq. ft.		.48

B. Cost of 100 sq. ft., 8-in. wall, built of light-weight concrete tile.

226 tile at $100.00 per M	$22.60	
9 cu. ft. mortar at .34	3.06	
Labor (450 per day)		
Masons, 4 hrs. at $1.00	4.00	
Tenders, 4 hrs. at .50	2.00	
Total cost per 100 sq. ft.		$31.66
Total cost per sq. ft.		.31½

C. Cost of 100 sq. ft., 8-in. wall, built of concrete block, 8x8x16.

112 block at $250.00 per M	$28.00	
4 cu. ft. mortar at .34	1.36	
Labor (160 per day)		
Masons, 5 hrs. at $1.00	5.00	
Tenders, 5 hrs. at .50	2.50	
Total cost per 100 sq. ft.		$36.86
Cost per sq. ft.		.37

D. Cost of 100 sq. ft., 12-in. brick wall.

2100 brick at $14.00 per M	$29.40	
29 cu. ft. mortar at .34	9.86	
Labor (900 brick per day)		
Masons, 19 hrs. at $1.00	19.00	
Tenders, 19 hrs. at .50	9.50	
Cost per 100 sq. ft.		$67.76
Cost per cu. ft.		.68

E. Cost of 100 sq. ft., 12-in. wall, built of light-weight building tile.

338 concrete tile at $100.00 per M	$33.80	
16 cu. ft. mortar at .34	5.44	
Labor (500 per day)		
Masons, 5½ hrs. at $1.00	5.50	
Tenders, 5½ hrs. at .50	2.75	
Cost per 100 sq. ft.		$47.49
Cost per cu. ft.		.47½

F. Cost of 100 sq. ft., 12-in. wall, built of concrete block 8x12x16.

112 blocks at $340 per M	$38.08	
5½ cu. ft. mortar at .34	1.92	
Labor (100 per day)		
Masons, 9 hrs. at $1.00	9.00	
Tenders, 9 hrs. at .50	4.50	
Cost per 100 sq. ft.		$53.50
Cost per cu. ft.		.53½

Summary. Cost per sq. ft.—	8-in. wall	12-in. wall
Common Brick	$0.48	$0.68
Concrete building tile	0.31½	0.47½
Concrete block	0.37	0.53½

These figures, which are very conservative, show how big an economy is gained in labor and mortar, even though the cost of the equivalent amount of brick, tile, and block is about the same. Records of an average of 500 tile per man per day are not uncommon. In two cases men have actually laid 900 in a day, but it is not wise to figure on this as a continuous performance, although claims are made that 600 should be a normal performance.

Labor efficiency, which decreased so seriously during the last five years, is improving, and as it reaches higher levels, the margin between the cost of concrete tile construction and other building units will be increased.

Crushed Brick Makes Good Concrete Block

Manufacturers of clay products have a large amount of waste due to overburning and breaking. This is the case no matter whether the clay products plant is manufacturing paving brick, faced brick, commons or sewer pipe.

It generally costs from 30 to 50¢ per ton to collect and dispose of unusable products, even if a dumping ground can be found close by.

One of the largest manufacturers of clay paving and faced brick in the central west was confronted with this problem, "What use can I make of my overburned brick and bats?" After carefully studying the problem, he decided that the brick could be crushed and made into concrete block.

Some preliminary experiments on a hand machine satisfied him that the crushed brick aggregate would make satisfactory concrete block. Engineers then designed a concrete products plant that when finished will cost in the neighborhood of $35,000. This plant has a daily capacity of 1800 block, and has operated at capacity ever since it was started. Early experiments showed that common or under-burned brick would not crush but balled and choked the crusher.

Concrete block made from crushed brick aggregate and portland cement has a reddish terra cotta appearance. While none of these block have been in the weather for a long period of time, those that have been exposed for about three months show practically no fading or discoloration.

A complete series of experiments was run in the plant to determine the most economical mix that could be used to produce a product of standard quality. As the plant is designed, the brick are delivered to the jaw crusher either by railroad cars from the company's out of town plants or by trucks from the local plant. The crushed brick is elevated to an overhead screen and separated into three sizes.

The fineness modulus of each of the three materials is as follows:

Size of Sieves	Fine Brick	Medium Brick	Coarse Brick
	Percentage retained	Percentage retained	Percentage retained
100	93	95	99
48	76	93	98
28	62	92	98
14	50	92	97
8	27	55	88
¼	1	5	78
⅜	0	0	15
F. M.	3.09	4.32	5.73

Salability is the first thing to be considered in the manufacture of concrete products. Second is quality—the product must be strong enough to meet the American Concrete Institute and Local Building Code requirements. Third, the block must be made as economically as possible. With these three things in mind, the following series of block were made:

No.	Cement	Fine Brick	Medium Brick	Coarse Brick
A	1	2	2	3
B	1	2	3	3
C	1	2	4	3
D	1	2	3	4
E	1	3	3	2
F	1	3	3	3
G	1	3	3	4
H	1	6	0	5
I	1	6	0	6
J	1	6	0	7
K	1	3	2	2
L	1	3	2	3
M	1	4	2	3
N	1	4	2	4
O	1	5	2	3
P	1	5	2	4
Q	1	4	4	4
R	1	4	5	4
S	1	5	5	4
T	1	6	5	4
U	1	6	6	4

V	1	7	4	4
W	1	7	5	4
X	1	7	7	2
Y	1	8	8	4
Z	1	10	6	4
1	1	9	5	2
2	1	9	4	2
3	1	8	3	2
4	1	8	8	0
5	1	8	6	0
6	1	8	4	0
7	1	8	2	0
8	1	9	6	0
9	1	9	4	0
10	1	9	2	0
11	1	9	0	0
12	1	10	0	0

The workability of each of the mixes was noted as the block were taken from the machine and placed on industrial cars. Salable surfaces and freedom from cracked webs were the two things that were taken into consideration.

The concrete was mixed for a period of from eight to ten minutes in an approved batch mixer, and as much water was added to the mix as possible and still not have the block sag when removed from the mold box. It was found that by training the off bearers we were able to strip block that were made very wet without cracking the webs. The block were immediately put into steam-curing tunnels of approved design and steamed for 24 hrs. at temperature of 100° F. after which they were removed to the yard and sprinkled for a period of two weeks. The block were then taken to an approved testing laboratory and subjected to a compression test.

Owing to the fact that some of the block produced were too rich and others too lean and still others too rough to be salable in the local market, only those block were tested that seemed to be economical and still salable. The following table shows the results of the series that were tested:

No.	Fineness Modulus	Yield in block per sack	Crushing strength in lbs. per sq. in. of Gross cross sec. area	Average crushing strength in lbs. per sq. in. of gross cross sectional area
A	4.56	15	1560 N.B.*	
A	4.56	15	1515	1395
A	4.56	15	1110	
F	4.38	18	1560 N.B.*	
F	4.38	18	1410	1510
F	4.38	18	1560 N.B.	
H	4.29	20	1525	
H	4.29	20	1400	1462
H	4.29	20	1560 N.B.	
N	4.38	24	1560	
N	4.38	24	1560 N.B.	1560 plus
N	4.38	24	1560 N.B.	
T	4.19	28	875	
T	4.19	28	880	890
T	4.19	28	915	
V	4.11	30	780	
V	4.11	30	730	760
V	4.11	30	770	
Y	4.07	37	715	
Y	4.07	37	645	690
Y	4.07	37	710	
Z	3.97	38	695	
Z	3.97	38	745	665
Z	3.97	38	555	
1	3.77	30	635	
1	3.77	30	735	705
1	3.77	30	745	
3	3.72	25	965	
3	3.72	25	1020	998
3	3.72	25	1010	
11	3.30	17	817	
11	3.30	17	1002	871
11	3.30	17	795	

*No break,

In conclusion it might be noted that crushed brick aggregate, while it is a little harsher to work than a mixture of screenings and torpedo sand, is just as easy to work as straight torpedo and for a given amount of cement and a given fineness modulus of the aggregate, products of about the same strength will be produced as when ordinary aggregates are used.

There are doubtless many clay products plants that could advantageously make concrete block and brick from crushed brick aggregates.

Influence of Water Content on Heating of Aluminous Cements During Hardening

By J. Bertet

From a paper presented at the International Cement Congress, London, April 22 and 23, 1924. Reprinted from the *Structural Engineer*, London.

In 1921, on the occasion of crushing tests being carried out with hooped columns made in concrete composed of aluminous cement manufactured at Bex (Electro-cement), Prof. A. Paris, Engineer, drew our attention to the considerable heating disclosed on lifting out of the mold.

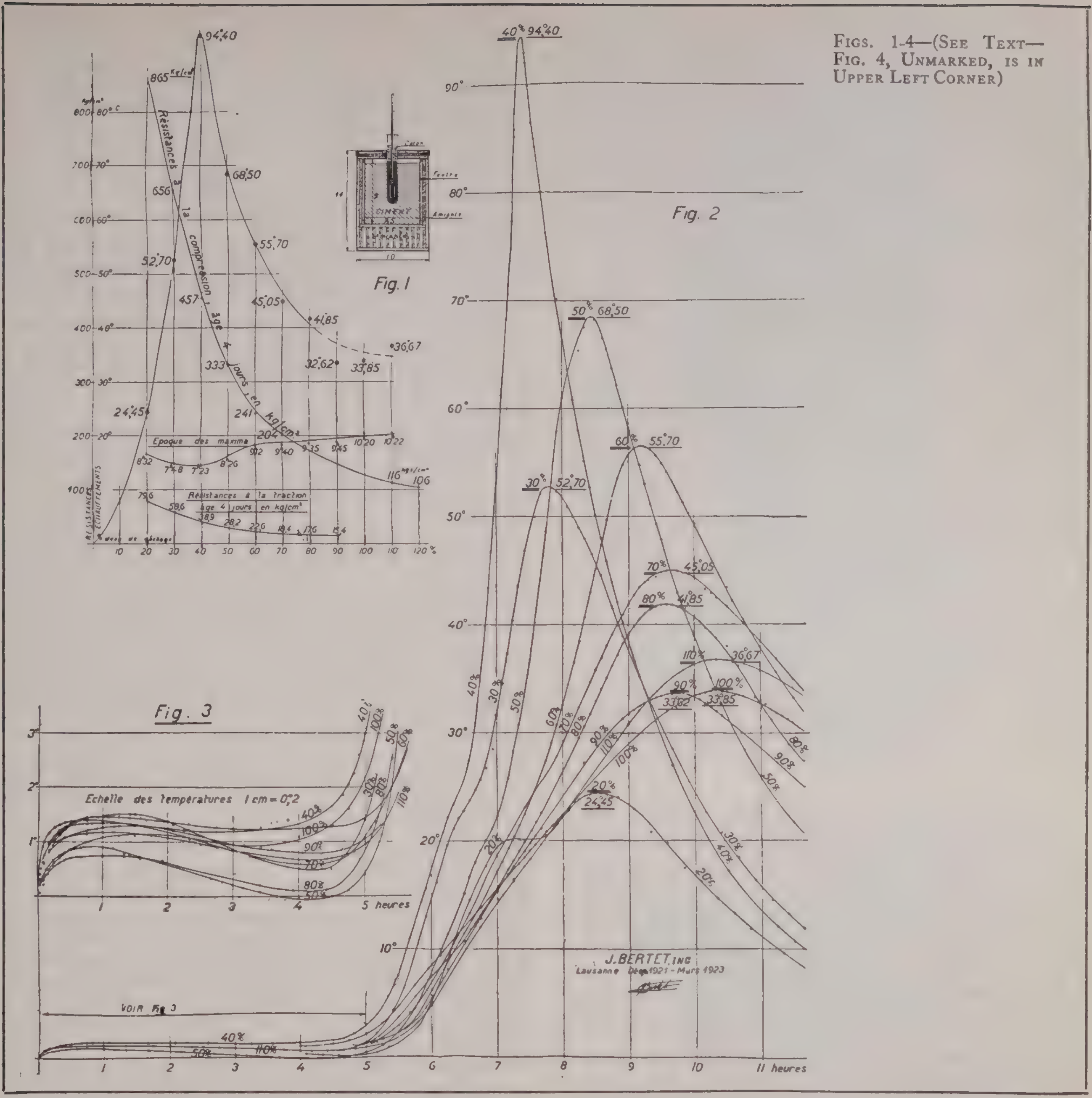
It appeared to us all the more interesting to study these exothermic reactions accompanying the hardening of aluminous cements, as these phenomena, common to all cements, portlands or quick drying, have been the subject of a great deal of experimental research since the year 1880; the newcomer into the cement family was the only one which so far had not been subjected to systematic tests of the same kind.

Our survey being confined to determining the heating curves and not the quantities of heat set free, we have replaced Tomei's calorimeter by a very simple contrivance diagrammatically shown in Fig. 1. The cement paste was run in a tin plate recipient of 3 in. diameter and 3½ in. high, placed inside a metal box 4 in. diameter by 6 in. high; insulating layers of felt and asbestos paper occupied the remaining free space. The temperatures were read with a 1/20° C. thermometer, dipping in the mercury of a glass tube emerging from the cement paste.

The electro cement pastes studied were composed of a fixed weight of cement (300 grs.), to which we successively added from 20 to 110% of its weight of water.

The thermometric readings are indicated in the chart hereunto annexed. Fig. 2 represents the ensemble of the heating curves in function of the time, the parts relative to the first five hours being given on a larger scale in Fig. 3. Finally in Fig. 4 we have traced in function of the percentage of mixing water, the envelope of the maxima observed, the periods corresponding and the resistances to 4 *j* obtained in traction and compression.

It will be noticed that the heating curves are characterised by the presence of two maxima and one minimum. In fact, the temperature of the paste rises at first rather rapidly attaining values, but little different; two suspicuous cases being left out of consideration, the differences do not exceed 13% on either side of the common mean, i. e., 1°32; the periods, likewise showing little variation, are comprised between 1 hour and 1 hour 40 min.; it seems that the reaction corresponding to this part of the diagram is the same in all cases of



Figs. 1-4—(See Text—Fig. 4, Unmarked, is in Upper Left Corner)

wetting. Afterwards the temperature lowers to the vicinity of 4 hours (except three isolated cases), rising rapidly and attaining variable periods of the characteristic values. In this part of the curve we have observed for 40% of water speeds of 3°92 per minute. Starting from these maxima, the curve follows the cooling diagrams which do not come within the province of our survey.

Let us point out the singularities of the curves 20% and 50%. The first shows a very pronounced level (palier) in the neighbourhood of T— 7h and ⊿ t = 20° seeming to indicate a reduction (into two parts) of the reaction in course of progress; we have made this test several times, and each time found this point of inflection. The curves following from 30 to 70% disclose in the neighborhood of 20° a repercussion more and more deadened by the same cause. Finally the 50% curve shows a very clear minimum, although of low absolute value (0°05).

Fig. 4 sums up in a particularly striking manner the influence of the percentage of mixing water on the exothermic reactions which accompany the drying (hardening) of aluminous cements; starting from 20% beyond which limit one would have to have recourse to vigorous ramming on the placing in position of the paste, we obtained results as tabulated below:

For 20%	of water,	a maximum of	24°45	at the end of	8h 32
30%	"	"	52°70	"	7h 48
40%	"	"	94°40	"	7h 23
50%	"	"	68°50	"	8h 26
60%	"	"	55°70	"	9h 12
70%	"	"	45°05	"	9h 40
80%	"	"	41°85	"	9h 35
90%	"	"	33°62	"	9h 45
100%	"	"	33°85	"	10h 20
110%	"	"	36°67	"	10h 22

It appears very clearly that the duration of minimum reaction corresponds to the maximum of elevation of temperature; it further seems that after 100% the variations are slight and tend towards the limit values. Finally, after 70% a part of the mixing water collects on the surface of the paste.

By chance we commenced our investigations at the fatidical percentage of 40%; in addition to the loss of two thermometers of too restricted a scale, we had the somewhat uncommonplace surprise of burning our fingers with the cement paste, a substance generally regarded as harmless.

We tried to ascertain the mechanical significance of the heating maxima by simultaneously carrying out the thermic tests and the tests with Vicat's needle. We did not find any relation between the three characteristic points of the curve of heating, and the guidance furnished by the penetration of the needle. It is nevertheless certain that the beginning and end of the hardening defined by the needle are always situated between the minimum and absolute maximum of the heating curve. In the case of the aluminous cements we find the same points of discordance as in the case of the portlands. It is advisable to remember that in the absence of any testing apparatus, Vicat was induced to conceive of a method giving comparable values by adopting as the end of setting, that moment when the cake of cement or hydraulic lime could no longer be scratched by the finger nail. It is evident that so arbitrary a definition could not take into consideration complex chemical reactions of hardening and setting; it is clear that the persistent efforts made from Tetmayer's time (1883) to that of Killig (1918) could not succeed in deducing from the tests a law connecting the indications of the Vicat needle with the exothermic phenomena of the setting. Kallauner at least was powerless to establish a relationship between these two factors and the variation of electric conduction of the cement paste when set.

On the other hand, aluminous cement seems to obey E. Schmidt's law; we have, as a matter of fact, noticed that the quantity of superficial water was entirely or partly immediately absorbed at the maximum heating moment of the testing apparatus. In order to fully study this connective phenomenon, we are now erecting an apparatus of the kind which Max Keller conceived in 1914.

Thus, therefore, the influence of the variation of the ratio (water:cement) is translated from the calorific point of view, by an increase, then by a continuous diminution of the heating resulting, thus causing a unique and very marked maximum to appear for the value 40%. A systematic analogous study not having been made (to our knowledge at least) in respect of portland cements, we thought that this unique fact in the cement family might involve peculiar mechanical properties in the aluminous cements; we were strengthened in this view by the fact that quick cements of the Porte de France tested in the same manner, gave results excluding the possibility of an intermediary maximum; we obtained the results tabulated hereunder:

For 25% water, a variation of 27°77 for T=33′
50% “ “ 22°70 for T=36′
75% “ “ 17°30 for T=43′
100% “ “ 13°85 for T=51′

These values are, in fact, very clearly situated on an equilateral hyperbole, analogous to that which Gary found in connection with the influence of the proportioning of the cement on the heating of quick cement mortars; the value corresponding to 100% alone slightly deviated from 11′.

In order, therefore, to examine the eventuality of a relation between the mechanical resistances and the extreme setting temperatures, we made, with the remainder of our supply of Bex aluminous cement, sets of three cylinders of 7 cm. diameter and 7 cm. high, as well as sets of three testing apparatus in eight. These bodies lifted out of the mold after 24 hours hardening, were kept in water for three days, the tests taking place at four days; one knows that at this age 85 and 95% of the total resistances are acquired by the aluminous cements. The mean of each set gave us the results hereunder, which experience the effects of the lack of freshness of the cement used:

Water/Cement	Compression	Traction	$K=\frac{\text{compression}}{\text{Traction}}$
20%	865 kgs/cm$_2$	79.2	10.9
30%	656	58.6	11.2
40%	457	38.9	11.7
50%	333	28.2	11.8
60%	241	22.6	10.6
70%	204	18.4	11.8
80%	deficiency	17.6	....
90%	do	15.4	....
110%	116	deficiency	....
120%	106	do	....

These results shown in Fig. 4, indicate clearly the independence of the two factors considered; the resistance is independent of the heating during setting.

We cannot make any mechanical property correspond to the maximum of intensity of the exothermic reactions; we temporarily set aside the physical properties such as the variation of the apparent and absolute volume, as well as the absorption of water, these questions being under consideration. Positively, the maximum of heating is not connected with the minimum of duration of the exothermic reactions; the proportion of 40% corresponding to 94°40 attains this value at the end of 7 hr. 23 min., lower than all the other values.

The very high temperatures which correspond to the considerable heating which we have just mentioned, may cause some anxiety, and give rise to doubt regarding the practical value of aluminous cements. The numerous and important works carried out since this product was placed on the market, suffice to prove that apart from certain very special cases, this calorific energy liberated at the moment of setting does not constitute a danger for constructional work. It is, moreover, easy to find the reasons for this.

We have, in fact, voluntarily operated on the pure cement paste in a sufficiently insulated vessel; under circumstances of a still more arbitrary nature, still more intense manifestations may be produced; all that is necessary is to improve the conditions of insulation. We know that with cubes of 20 cm. edge, Bied found temperatures of 175°. Mr.Feret has informed us of burstings and projections of material, accompanied with intense setting free of steam, in acting simply on 40 cm. cubes. It seems, therefore, that these manifestations are evidently dependent on the self-insulation of the body as a result of its dimensions allowing of a considerable accumulation of heat, and moreover richness of the proportion.

We have examined the influence of the thinning of the mortar by means of a final trial series; with a fixed weight of 420 grs. of cement paste with 40% water, we have incorporated increasing weights of normal sand. We have thus obtained:

For the proportion 1 cement : 0.5 sand, Heating of 48.9% of that of pure paste
“ 1 : 1 “ 40.1% “
“ 1 : 2 “ 30.4% “
“ 1 : 3 “ 23.0% “

With a constant plasticity this fall would have been still more accentuated, as a result of the necessary increase in the quantity of water. However, if we consider, on the basis of these results, unfavorable to our next conclusions, the probable elevation of temperature of concrete, 300 kgs. per m^3, that is in weight about 1:7, we will find 15% of the maximum, or 14°; this limit value, possible in the case of more insulating cofferwork than those of the usual practice of the yard, is in any case inferior to the rules laid down by the official regulations for the calculation of the strains due to the variations of temperature. On the other hand, the study of the coatings at 600 kgs./m^3 would lead us to 22% approximately of the maximum or about 42°; but the insulation of the coatings surfaces being nil, it is probable that the real heating would be lower, or at most equal to that of the concrete at 300 kgs. For prudence sake, however, it is advisable not to use higher coating proportions.

As regards the influence of the dimensions, it is necessary that the constructors should take advantage of the making of large piers (massifs) to study the interior regime of the temperature, which is certainly different from that of the same piers concreted in portland cement. We would recall that such tests were made during the concreting of the locks of the Panama canal, also at the time of the construction of the dams (barrages) known as the Kensico, Arrow-Rock, Jogne and Barberine, the two last-named in Switzerland; they show that the internal temperature tends towards 30° and that this maximum is not established for about 20 days.

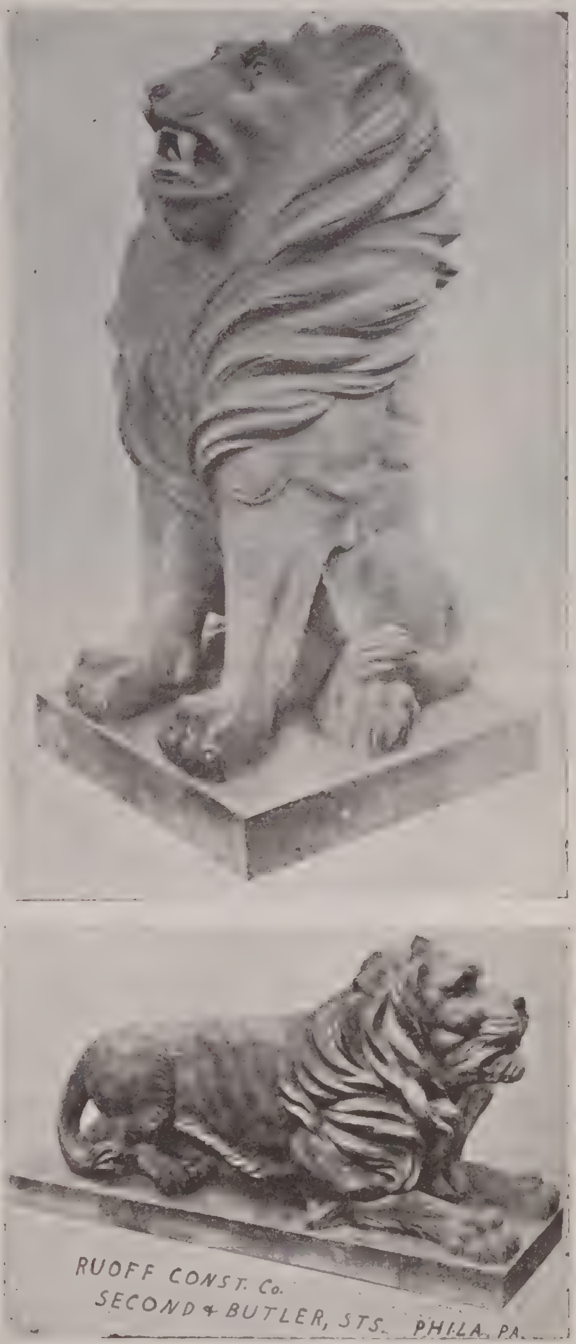
Before terminating this paper, we should like to point out how absurd it is to judge a cement on its heating degree during setting. It is curious to find that Clause 8 of the argenti Regulation qualifies as suspect any cement showing an elevation of temperature of more than 2°. Also in England it is the practice to regard as defective cements which heat to 6°F. when making the "Marmelade pot test." Such practices which Mr. Oscar Faber refers to as "Fallacious tests" would relegate aluminous cements to the category of the doubtful. Moreover, the recent researches of Killg (1918) have shown that the reversibility of the cements (Umschläger), and the ball setting of certain products is due to their content of unburnt parts; but contrary to the generally admitted opinion, the heating of these parts is lower. On the other hand, the temperature maximum occurs sooner than in the case of the sound product, artificially made reversible for the study of this phenomenon. In accordance with our observations, we think that the only practical use that can be made of the heating of cements lies in the quantitative estimation of the deadening (éventement.)

Finally from the theoretical point of view the knowledge of the setting temperature diagrams may serve for studying the chemical constitution, and the nature of the hardening reactions of aluminous cements. These curves, well characterized by the two maxima, disclose the succession of two distinct reactions. It is clear that in knowing the heating curves of the constitutive elements, probable or possibles, it will be possible by successive accumulation to reproduce the diagrams of the cement itself. This synthesis, difficult to carry out in the case of portland cements, seems more easy here on account of the ampleness and character of the exothermic phenomena which we have just described. We will return to this subject later on, tests based on this method being in process of preparation.

A. C. I. Membership

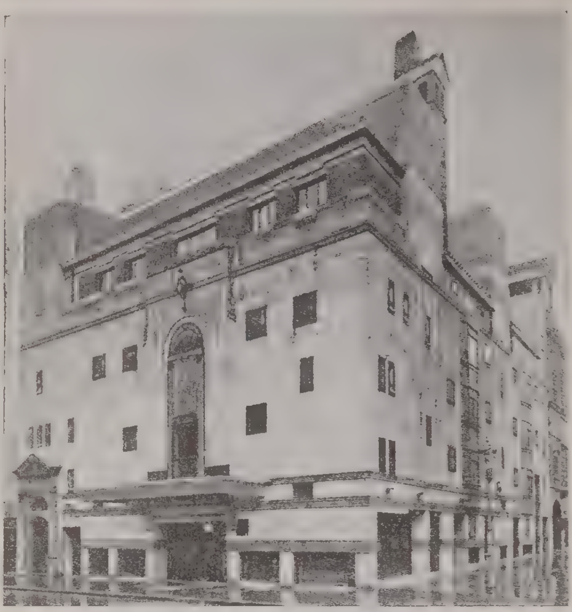
A summary of the gains and losses in membership of the American Concrete Institute for the fiscal year ended June 30, 1924, shows that from active membership 104 were lost, 2 simply represented changes to supporting membership, 2 by death, 48 by resignation, and 52 dropped for non-payment of dues. On the credit side, 401 applications for membership were approved, and 7 former members were reinstated. This made the total active membership July 1, 1924—1191.

In the same period, 8 supporting members resigned, and 7 were dropped for non-payment of dues. On the credit side 40 were added to the supporting membership list, 2 of them by changes from active membership to supporting membership, making the total supporting membership July 1, 1924, 98, and the total membership 1289.



Lions Made in Piece Molds

These two lions are shown chiefly for their interest to the ornamental products man because of the way the castings were made. They were made of concrete in plaster piece molds by Julius Ruoff, manufacturer of ornamental concrete in Philadelphia. The reclining lion id 48 in. long, 24 in. wide and 22 in. high—weight 650 lbs. The upright lion is 24 in. square and 36 in. high—weighs 350 lbs. The original models were carved from solid slabs of plaster from which the plaster molds were made in from 45 to 50 small pieces so the casting would "draw." The mix was of three parts white Tuckahoe marble and one part Atlas white cement. These lions were made for Dr. Rogers—Atlantic and Bartram Avenues, Atlantic City, N. J.



Fortune Theatre, London

Fortune Theatre—A London Surface-Treated Concrete Facade

From *Concrete and Constructional Engineering*, London.

In the new Fortune Theatre building the chief point of interest to the structural engineer is the construction of the external walls, which are of concrete mainly, 5 in. thick, reinforced with a single layer of vertical and horizontal Truscon deformed bars.

The smallness of the site necessitated a choice of construction which would yield the greatest saving in space, and after careful consideration, ferro-concrete was decided upon, without any facing of brick or stone. The consequence of this is that actually only 5 in. of ferro-concrete separate the upper circle wall from the building line. The London County Council Regulations demanding at least seven days before centering is struck, prevented effective brushing and washing, and the automatic bush-hammer was resorted to. Otherwise, the concrete face would have presented a much more colored and sparkling appearance, since any tool work on spar or marble has the effect of deadening the refractive value of the material. All windows are made of mild steel, and the frames are set in the face overlapping the concrete, the windows being thus more or less flush with the building line. This saves special reveal work. No attempt has been made to mold the concrete in any way, and the only ornamentation introduced are ribbons of cast lead.

A specially selected felspar aggregate was used for the outside face, and the surface bush-hammered to expose the pinkish stone. The concrete for the outer face was placed at the same time as the concrete on the inside face, which was made with crushed ballast. The architect has been very successful in his attempt to demonstrate that a concrete external surface can be made very pleasing to the eye, and need not be hidden, as is usually done with stone or brick.

The site is so small that every inch is of value, and this made thin walls desirable, apart altogether from the saving in the cost of facing stone.

The walls are carried on reinforced concrete columns of rectangular section, running from mass concrete foundations below the basement to the top floor level, above which are brick walls and a slab and tiled roof carried on steel frames. The internal framework is of steel. The steelwork carries reinforced concrete floors (Truscon designs).

The problems of the architect were considerably complicated by the necessity for maintaining intact the passage-way from Russell Street to the Scottish Church behind. The theatre is both above and below this passage, and the work of underpinning the passage walls was not without its anxious moments; however, "Church and Stage" have again been successfully blended. The underpinning of the thick wall at the back of the stage was fairly simple. The columns against this wall are of reinforced concrete, as it was originally hoped that negotiations with adjoining owners would result in these columns being omitted, but they now extend to the roof and carry the grid floor and the 9-in. wall against the original wall, being quite independent of it.

It was originally intended that the roof above the stage should be a light structure offering little resistance to fire on the stage, but later requirements called for a steel frame cased in concrete with a steel and glass lantern.

In addition to the outside walls and columns, the framework for the stage wall on the Crown Court side is of reinforced concrete, the dressing-room floors, brick walls, and roof being carried at three levels.

The cantilever retaining wall extending the basement area below the pavement of Russell Street and Crown Court is also of reinforced concrete. It was originally intended to construct the proscenium arch of the same material, but a heavy steel girder carried on reinforced concrete columns was substituted.

The architect is E. Schaufelberg.

This is the first theatre to be built in London since the war, and its name, "The Fortune," revives the name and memory of the famous house of the same name which formerly stood on the same site and in which Shakespeare acted.

Proportions and Consistencies of Concretes

Some time ago, the Commissioners of the District of Columbia requested the Bureau of Standards to obtain information relative to local concrete materials; the data to be used in redrafting certain portions of the District Building Code. This work was completed during the past month. The particular information desired was the effect of different sized aggregate on strength of concrete and the strengths which might be expected under laboratory conditions for different proportions and consistencies.

The cement used was a composite made of seven different brands furnished by various building supply firms in the District, while the sand was obtained from dredging companies, screened through a No. 4 sieve, thoroughly mixed while damp, and sacked. It was allowed to dry in the sacks before being used in the tests. The gravel was washed, dried, and screened into separate sizes when received. A mechanical analysis was made of the lots as received, and the screened material was recombined in uniform proportions for the tests in practically the original gradation.

The batch for each 6 x 12 in. cylindrical specimen was proportioned by weight and mixed by hand. Each mix was made with nominal 1½ in. and ¾ in. gravel, as used in the District, and with two consistencies such as would give slumps of 6 in. and 9 in. when measured by the slump cone. Five different specimens were made on 5 different days for each mix and consistency. The specimens were cured under damp storage conditions, and the strengths obtained at the age of 28 days.

The essential data obtained from these tests are included in the following table:

Data of Concrete Tests

Mix (By Wt.)	Aggregate (in.)	Water (1) (Per cent)	Slump (in.)	Weight per cu. ft. (lbs.)	Density	Yield	Amount (2) of cement (Percent)	Unit Comp. Strength (lb.sq.in.)
1:1:2	1½	9.9	6.5	146.4	.774	1.58	35.4	5210
		11.5	9.1	144.8	.754	1.62	34.5	4230
	¾	10.1	5.6	146.1	.770	1.56	35.3	5220
		11.8	8.9	144.1	.750	1.60	34.3	4560
1:1:2½	1½	9.2	6.2	147.2	.786	1.41	31.8	4970
		11.1	9.0	145.5	.764	1.45	31.0	3680
	¾	9.5	5.4	147.1	.784	1.39	31.8	4970
		11.1	8.8	144.8	.760	1.43	30.8	3980
1:1½:2½	1½	9.2	5.9	146.2	.784	1.57	28.5	4460
		11.1	9.1	145.0	.765	1.61	27.8	3520
	¾	9.5	5.5	146.2	.782	1.55	28.4	4680
		11.5	9.3	143.9	.757	1.60	27.5	3410
1:1½:3	1½	8.8	5.8	147.0	.794	1.43	26.1	4090
		10.6	9.1	145.8	.775	1.46	25.5	2980
	¾	9.1	5.8	146.7	.791	1.41	26.0	4330
		10.9	8.8	144.4	.764	1.46	25.2	3170
1:2:3	1½	9.2	6.5	146.1	.789	1.57	23.7	3850
		10.9	9.1	145.1	.772	1.61	23.2	2800
	¾	9.1	5.4	145.7	.788	1.55	23.7	4060
		11.2	9.0	143.7	.761	1.60	22.8	2700
1:2:4	1½	8.7	6.5	146.4	.797	1.37	20.1	3360
		10.5	8.6	145.2	.778	1.40	19.6	1790
	¾	8.9	5.5	146.0	.793	1.35	20.0	3210
		10.8	8.9	144.1	.769	1.40	19.4	1710

(1) Percent of total dry. (2) Percent of bulk cement per unit of finished concrete.

Silicate of Soda as a Concrete Hardener

The objects which it is sought to accomplish in the use of sodium silicate to increase the resistance of concrete to wear and tear through hardening and densifying it are given in a folder issued by Brunner, Mond & Co., Ltd., England. The main object is the absorption of the silicate, so that by reacting with the cement (1) it fills up the pores of the surface concrete, (2) combines with the free lime and, by forming calcium silicate or calcium chloride, increases the strength of the cement. In this way, it is claimed, a dense resistant layer ⅛ to ¼ in. thick is formed, which, besides binding the particles of the concrete more firmly, waterproofs the surface.

The company has issued a pamphlet explaining the general action of the silicate of soda and dealing with the question of dust-proofing and hardening concrete floors and concrete roads, waterproofing concrete, the treatment of oil storage tanks, the effect of silicate of soda added to water used for gauging concrete.

Reviewed briefly, silicate of soda is manufactured by fusing soda ash (carbonate of soda) with white sand of good quality. By this process, a glass is formed, somewhat resembling ordinary glass, which, owing to the absence of calcium and lead and under suitable conditions, can be dissolved in water. It is possible to vary the proportion of silica and soda which such glasses contain, and the properties of the solution formed by dissolving these glasses are dependent upon the ratio of silica to soda present.

Brunner, Mond & Co. recommend the use of a solution containing a much higher proportion of silica to soda than the ordinary water glass of commerce. The handiest and most useful sodium silicate is given as what is known as 3.3 ratio, because it contains 3.3 molecules of silica per molecule of soda. It can be obtained in concentrated form capable of being diluted with 5 times its own volume of water.

The following are the instructions given by the manufacturers for the treatment of concrete roads and floors with silicate of soda.

1. It is important that the silicate of soda should be mixed with four times its volume of water before it is applied to the concrete. If a stronger solution is used adequate penetration of the pores of the concrete cannot take place and the maximum benefit of the treatment will not be obtained.
2. Before treatment the concrete surface must be clean, free from grease and dust, and comparatively dry.
3. The concrete should be well watered with the dilute silicate and a soft brush or mop used to spread the solution evenly over the surface, care being taken to keep the concrete wet long enough to ensure penetration.
4. The concrete should be allowed to dry for 24 hours, and the process repeated.
5. After another period of drying, a third treatment should be given in the same way.
6. The quantity required varies slightly according to the porosity of the concrete. Usually 1 cwt. of P. 84 silicate is sufficient for the complete treatment of 300 square yards.

Removing Reinforced Concrete Wall With Dynamite

The manner in which a reinforced concrete wall was removed with the aid of dynamite by the Illinois Central Railroad is of interest, particularly in view of the frequent necessity for removing concrete structures, or parts of them without serious injury to other nearby structures. The concrete removed, as shown in the accompanying illustration and described in *Successful Methods*, was the wall between some cinder pits and was 9 ft. high, 24 in. thick at the top and 36 in. thick at the bottom, reinforced with ⅞-in. rods running both vertically and horizontally at 7 in. on centers. It was desired to convert two single pits into one double pit with a dumping track on each side.

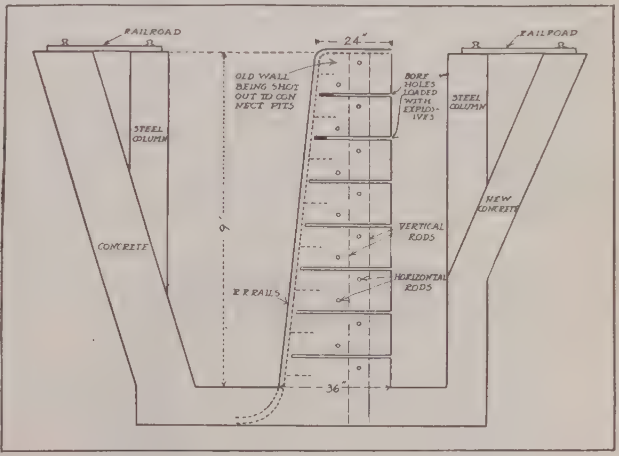


Fig. 1—Sketch Showing Old Wall and Position of Dynamite Charges with Reference to Outside Walls

The work was made more difficult by the fact that along the sloping face of the wall, with their base imbedded in the concrete and anchored with tie bolts, were railroad rails 18 in. apart. Tearing down this solid mass of concrete and steel with pick and sledge would have been a slow process and very costly, but with the aid of dynamite, it was made relatively an inexpensive job.

Holes were drilled into the concrete from the vertical side in a line with each rail and from 14 to 16 in. apart in the other direction.

Working from the top down, two horizontal rows of holes at a time were loaded with dynamite and fired. One-third of a cartridge of 40% ammonia dynamite and an electric blasting cap were used in each hole. These small charges tended simply to crack the concrete and loosen it from the reinforcing rods so that it could be removed piece by piece. To guard against the danger of possible flying fragments, the work was covered with heavy plank and while the shooting had to be done between movements of engines over the adjoining track, the work of the men in an oil house 16 feet away was uninterrupted by the blasts.

Two walls were removed in this manner containing together about 120 cu. yds. of concrete. The blasting was done by Paul R. Higgins, Fort Dodge, Ia.

Reinforced Concrete Safe Doors

As is generally known the ordinary steel safe consists of an inner and outer steel shell, the space between being filled with fireproof material. While under ordinary circumstances such a safe may be regarded as fireproof and thief proof it cannot withstand the application of the oxy-acetylene blow pipe, and filling the safe between the plates with concrete still leaves any metal connection between the inner and outer skin as a vulnerable point. Thirdly, steel plating is well known to become soft enough during a fire to cause a virtual collapse of the safe in the likely event of its falling.

To overcome these shortcomings the reinforced concrete safe has been introduced. While on the face of it there would not appear to be any distinct novelty in the departure, yet in actual practice considerable ingenuity in the design is called for so that there may be a minimum of exposed metal while the concrete requires to be so disposed as to resist drilling.

Fig. 1. gives a sectional view of a safe constructed on these lines. The reinforcement, it will be seen, consists of staggered bars *a* of twisted steel, an inner and outer layer of expanded metal *b* and corrugated expanded metal *c* in the space between. The distance between the twisted bars *a* is so arranged that the arm cannot be passed between them in the event of the concrete and expanded metal being cut away. The twisted bars, it might be noted, are regarded as being particularly effective in resisting drilling and cutting.

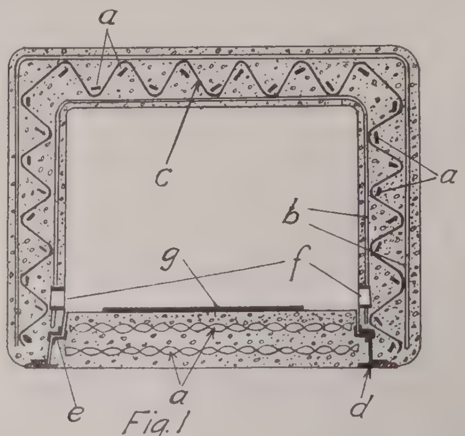


Fig. 1

Door

The door, it will also be observed, is mainly fashioned of concrete. In order to prevent the penetration of flame or hot gases around the edges there is placed a rim of steel fitting into a ring set in the body as shown at *d*, while at *e* is a double rebate of sectional steel which provides an efficient firelock. The pockets *f* in the door opening through which the bolts pass are steel lined, but there is no metallic connection between the inside and the outside of the safe at any point. The locking mechanism is of course, wholly of metal and is mounted on steel plate *g* secured by embedded bolts. These safes, which have walls 3½ in. to 6 in. thick, according to requirements are obviously constructed of the finest grade of concrete it is possible to mix, the surfaces being subsequently rubbed down, painted and varnished and the fittings nickel plated. The finished article has an appearance comparable with the best steel work.

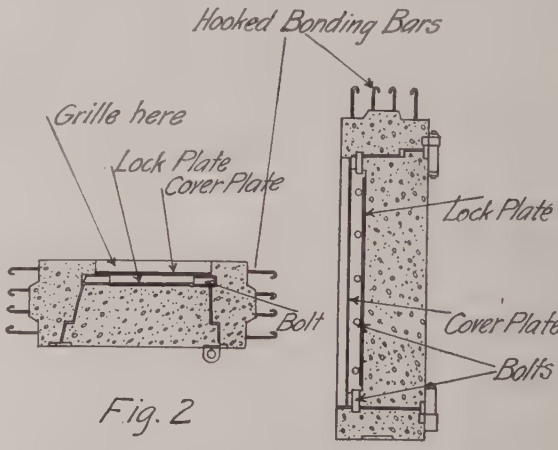


Fig. 2

Strong Room Doors

Fig. 2 shows the general form adopted for these, the thickness varying from 6½ in. to 20 in., the largest size of the latter thickness weighing some four tons. The frames are also of reinforced concrete with the necessary hooked bonding bars. The doors themselves which are reinforced much in the same way as the safe doors are constructed as solid masses of reinforced concrete, steel edges being provided to prevent damage by rough usage.

Joint Committee Report

The revised report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete is about ready for transmittal to the five organizations cooperating on this committee—the American Society for Testing Materials, American Society of Civil Engineers, American Railway Engineering Assn., American Concrete Institute, and the Portland Cement Association, says an American Concrete Institute *News Letter.* The report is at least as large as the report submitted in 1921, which fills seventy-five printed pages. The five organizations are cooperating in the joint publication of this report, which will be in members' hands this fall.

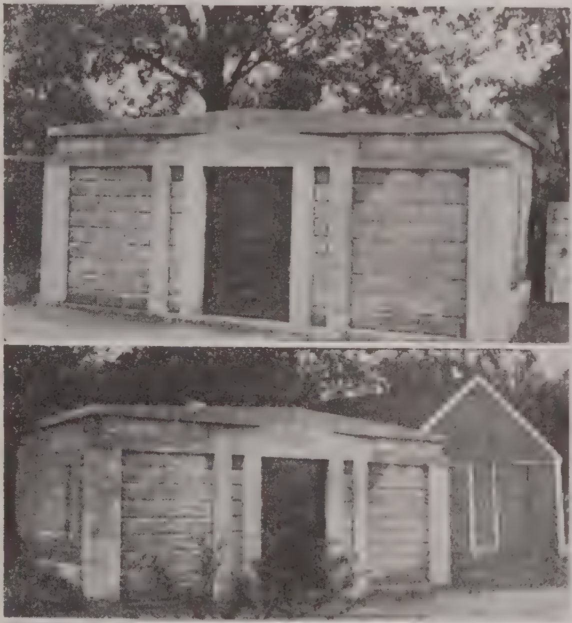
Concrete Masonry for Receiving Vaults

By Charles F. Dingman

Would a building of ordinary concrete block construction present an appearance of character and dignity in keeping with its location in a first class cemetery? We didn't believe it would. And we were frank to tell the Cemetery Commissioners of the Town of Monson so, when they asked us for an estimate of the cost of increasing the size of their receiving vault.

The vault had been built in 1863, with a dressed granite front, consisting of the lintel shown in the picture, the four pilasters shown under the lintel, and the two corner posts. In the previous construction, the door being narrower than the new door, the stones that now serve as corner posts were flat panels between the pilasters.

The rear and side walls were granite rubble. The floor and roof were granite slabs. Practically all of the structure, except the front, was concealed by an earth filling. Ventilation was secured by a 2-in. iron pipe through the roof, at the rear and by an allowance of about ¼-in. over and under the door at the front.



Figs. 1 and 2—Cemetery Receiving Vault at Monson, Mass.

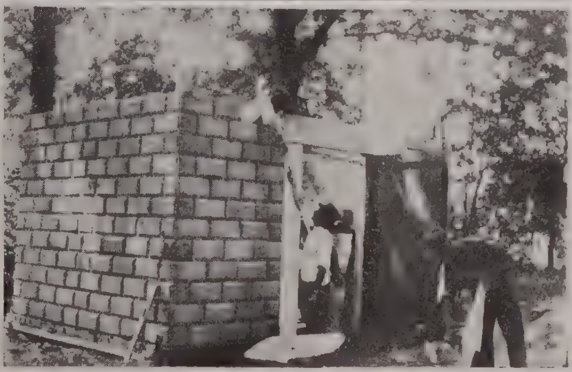


Fig. 3—Another Concrete Masonry Vault at Wilbraham

The Commissioners were anxious to retain the old granite in the new front, but because they were limited as to available funds, it was essential that they get as much space in the new portion of the structure for as reasonable a cost as possible.

Accordingly, they developed the design shown in the pictures. It comprises an entirely new chamber, about 9 x 14 ft., inside dimensions, with the old chamber extending out in the rear, forming an approximate "T" in plan.

The rear wall of the new chamber, as it comes against the old earth fill, is of poured concrete but the side and front walls above the foundation, except for the granite shown, are of ordinary panel faced concrete block.

Ventilation is provided by means of a 6-in. metal ventilator at the rear and by the perforations, which form the numerals 1923, in the door.

The roof is of poured concrete, reinforced in both directions, and floated off on top but not otherwise waterproofed. On the night after this roof was poured, the temperature fell considerably below freezing and, although the only protection was a covering of ordinary tar paper, the roof has shown no signs of injury nor has its service during the past winter indicated the need of anv waterproofing.

The floor is pitched to a sump at the junction of the old and new portions and from there drained to the nearby roadway by a tile pipe.

When we had the vault completed, we had so far changed our opinion of its suitability that we told our friends about what a good job we had done, and the Commissioners backed us up in telling how well satisfied they were.

As a result, our local papers carried a description of the vault and it came to the attentilon of the Trustees of Woodland Dell Cemetery in Wilbraham. They investigated and agreed that the appearance of the Monson Vault was up to the standard of their requirements.

Accordingly, they had a design prepared and told us to go ahead with the construction of a vault for them. The Wilbraham vault is 9 x 15 ft. inside dimensions and 8 ft. high.

In building the foundation, the trenches were dug the net width of the footing and only an outside form used. Coarse gravel was filled in between the footing lines and the underside of the floor. Then the floor and foundation were poured in one operation.

The door jambs and lintel are of cut granite, as indicated in the illustration, and the wall and roof construction follow that of the Monson vault.

As an added precaution, the top of the roof was given a coating of Hard-N-Tyte[1] and the entire interior was coated with the same material.

These two structures seem to indicate that, properly handled, concrete block can produce a structure in harmony with practically any surroundings.

A. C. I. Convention, Chicago, February 24-27, 1925

As a result of an advisory ballot of the membership of th American Concrete Institute, the organization will return to Chicago again for its convention—the 21st annual meeting—Drake Hotel, Feb. 24, 25, 26, and 27, 1925.

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[1] General Chemical Co., New York City.

Training Dannemora's Guests in Concreting

F. A. Heimbold, superintendent of construction at Clinton Prison, Dannemora, N. Y., holds one of the most difficult and at the same time most interesting positions in the building business today.

Several years ago Mr. Heimbold left New York City for the Adirondack Mountains to recuperate from a nervous breakdown and the curative effects of this climate made it desirable for him to remain in the vicinity, at least. Dannemora is in the foothills of the Adirondacks and the State of New York, by whom Mr. Heimbold was employed as an engineer, delegated him to be superintendent in charge of all construction pertaining to Clinton prison—building dams, roads, buildings.

The policy of the State was to have this work at Dannemora done by prison labor alone, in the hope that the men so employed would find an interest in the work and that on the completion of their terms in prison they would turn to a useful and constructive occupation and be a benefit instead of a menace to society.

Dannemora is often referred to as the "Siberia of America." To this institution is sent the supposedly incorrigle type of criminal. Sixty per cent of the inmates are confined in this prison for having committed murder and other heinous crimes; many are mentally deficient and the majority destructive rather than constructive by nature. Mr. Heimbold had a task to perform and these were the men from whom he had to choose to carry out his task. A very few, if any, had ever worked on construction. He had to teach them and has taught many of them; taught them everything from making drawings and using a transit to bricklaying, carpentry, and all the other trades incidental to work around building construction, but this teaching is only preliminary. With these men he has built up an organization and with this organization of approximately 150 men, changing constantly, one shift in the morning and one in the afternoon, he is accomplishing an astounding amount of actual completed good work in remarkably short time.

Among the various activities which he has established and which are operated under his direction, is a quarry from which the stone is blasted to be used for concrete; a crushing plant that produces stone in various sizes for different classes of concrete work. Lumber is obtained from the State Forest Reserve and cut to proper sizes in a mill. The construction of the mill, its operation as well as the logging is done by "guests of the State" as Mr. Heimbold terms them. A carpenter shop has been erected where window frames and other finished wood work is made. A blacksmith shop has also been erected where metal frames, anchors, tools, etc., are being turned out. Mr. Heimbold has himself constructed models for the education of the men so that when they were required to do the actual work they had a fairly comprehensive idea as to what they were trying to accomplish.

As this is written, a building is under construction which is 60 ft. x 300 ft., three stories and a basement. The exterior walls and floors are of reinforced concrete and the floors are supported by structural steel columns and beams. This work is going on at a rate that would be a credit to any contracting organization. Steel Metaforms[1], are being used for forming the concrete walls and the unskilled men to accomplish good work. These steel forms are constructed in various widths up to 2 ft. The largest panel is 2 ft. square, and these units are assembled in larger panels and handled as large units, for plasters, offsets of various kinds, and columns. Each steel form unit is locked to the adjoining unit by a malleable clamp which is attached to and is part of the form. The alignment of one form unit with another is automatically governed by steel dowel pins attached to the form and steel spreaders assure proper spacing between the sides. The forms are set in courses each 2 ft. high, and after the first course is set and leveled. In stripping forms one course is left in place against the concrete and this course in place supports the succeeding course on top. The forms are oiled between each use with a light paraffin oil so that the resultant work is smooth.

A constant check must be kept on the concrete mixture for the men are at times inclined to leave out the cement, as one convict said "the stuff is not so sticky when we leave out the cement." Two negroes were laying up a brick facing and were caught using wet sand as a mortar and when asked why they left out the cement replied "it is not nearly so sticky as regular cement mortar and much easier to mix." There is a negro stone cutter who has become really proficient in his work but can count only to four. A very few of the men can use a rule or measure.

It is, of course, impossible to organize such a construction gang of convict labor where one convict would be in authority over another so that Mr. Heimbold, in addition to being superintendent of construction is also, of necessity, a foreman and straw-boss for each of the trades on each of the gangs. He has, to be sure, the assistance of guards or officers who act as gang foremen. However, these officers are not trained construction men and can only see that the men keep working, as many of the convicts would prefer to sit down and talk all day rather than work.

Many of the men are becoming more and more interested in their work. They are learning trades and doing healthy out-of-door work.

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[1] Metal Forms Corporation, Milwaukee.

Warm Air Heating Systems

An investigation of warm-air furnaces and heating systems has been carried on by the Engineering Experiment Station in cooperation with the National Warm-Air Heating and Ventilating Association since October, 1918. The principal objects of the investigation are, briefly, to determine methods of increasing the efficiency and capacity of warm-air furnace heating systems, and to establish satisfactory and simple codes for testing and rating furnaces, so that the heating equipment may be properly proportioned for the work it has to do.

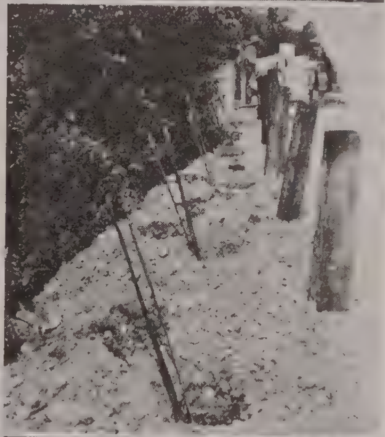
Bulletin No. 141, Engineering Experiment Station, Urbana, Ill., is the fourth to be published in connection with this investigation, and gives valuable information concerning the work accomplished since the publication of the third report, Bulletin No. 120, in March, 1921.

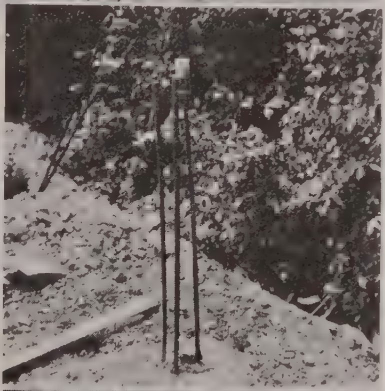
If there is a man in overalls in your employ who is a skillful workman and takes pride in his job—let's hear about him and what he does.—Editor.

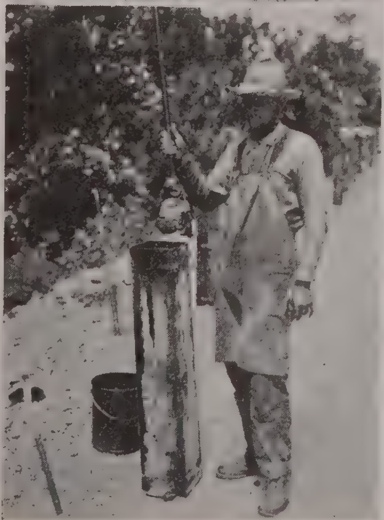
Making Concrete Guard Rail

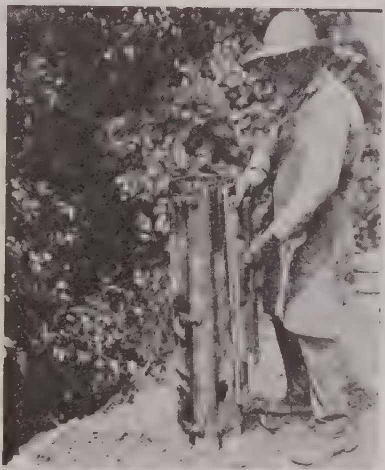
The pictures show the making of a guard rail in the Joplin, Mo., Special Road District. This protection to road users has cast-in-place concrete posts, and a gang of eight men with a team builds an average of 240 ft. of guard rail a day, at a cost of less than $1.00 a foot.

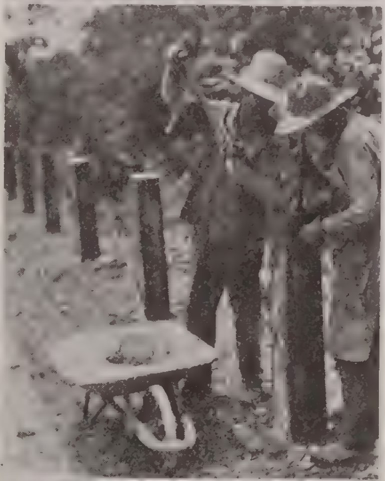
Holes are dug 3 ft. deep (Fig. 2), filled with 1:4 concrete, and the reinforcing steel rods set up (Fig. 3). Next comes the well-oiled two-piece steel forms, which are set on the fresh base concrete (Figs. 4 and 5). A mix of 1:3 concrete, well spaded, is used for the upper part of the post, and the top is troweled over smoothly (Figs. 6 and 7). Protection is given the concrete while curing by a wet board placed on top of each post (Fig. 8). Completed, the posts are 6½ ft. long, 7 in. square on top, and 9 in. at the base. Each is a 400-lb. barrier against disaster. They are plainly visible at night without the addition of paint. Figs. 9 and 10 show the completed guard rail, with steel straps holding the rail to each post.

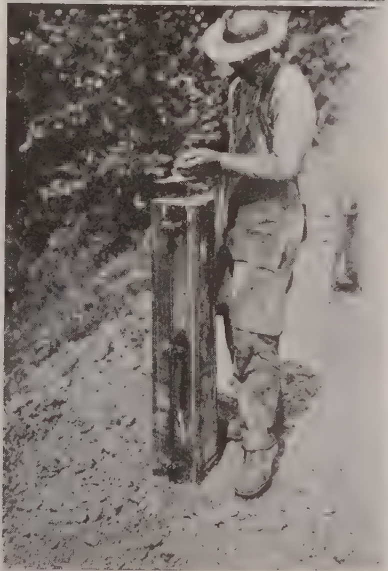


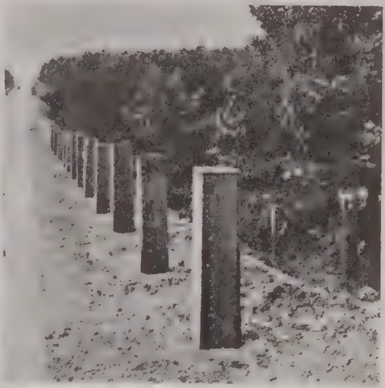


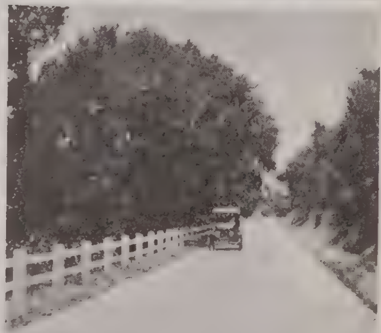


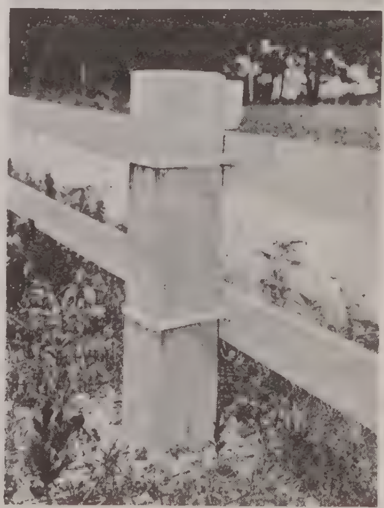










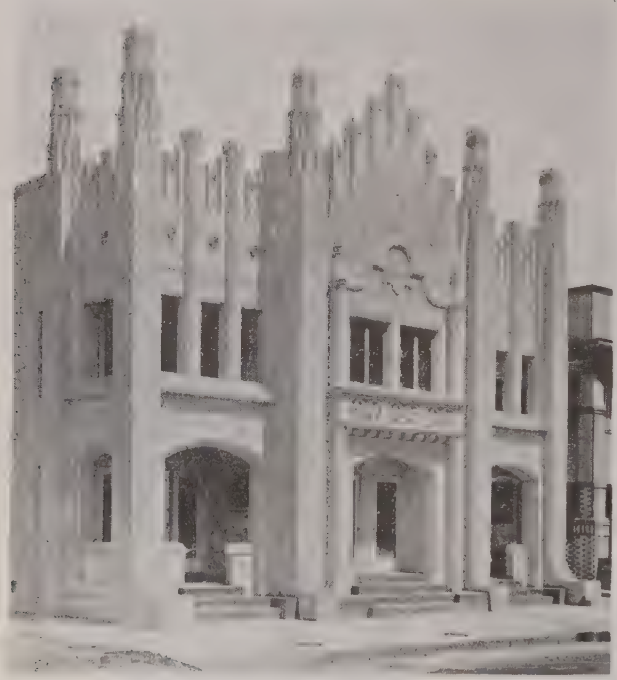


Figs. 1-4—(Top to Bottom, Left)

Figs. 5-7—(Top to Bottom, Center)

Figs. 8, 9and 10—(Right) See Text

Tudor Apartments—Designed for Concrete



The Tudor Apartments, Stockton, Calif., the work of Glenn Allen, architect, show more than an ordinary amount of originality in expressing the structural elements of the work. The Tudor apartments are reinforced concrete construction, with a dress of white stucco in sand dash finish. The trimmings are of precast concrete and glazed tile inserts.

"The parapet, while elaborate in appearance, is extremely simple to form of concrete," says Mr. Allen. "The recesses are secured by simply nailing pieces of the required size to the inside of the outside wall forms. The tile inserts were applied directly to the rough concrete, and stucco finished up to them."

Reading Fire Test of Cinder Block

A public fire resistance demonstration of Straub patent cinder block, made by the Berks Building Block Co., Reading, Pa., July 12, 1924, was referred to briefly in CONCRETE for August. From the report of E. L. Conwell & Co., Philadelphia engineers in charge of the tests, the following is abstracted:

Experienced masons put up a special building about 20 ft. x 12 ft. and 10 ft. high, using 637 cinder block, 8 x 8 x 16, 704 face clay brick and 130 hollow clay tile laid up in lime mortar. One partition wall of Straub block was loaded with 10 tons of pig iron. The interior was filled with oil-soaked cordwood.

Fire was started at 1:30 p.m., and was fed at short intervals with oil-soaked wood. Pyrometer readings showed interior temperatures as follows:

INTERIOR TEMPERATURES

Time	Temperature
1.45	710°F.
1.50	800°F.
1.55	1050°F.
2.00	1205°F.
2.05	1350°F.
2.10	1385°F.
2.15	1420°F.
2.20	1470°F.
2.25	1505°F.
2.30	1510°F.
2.35	1540°F.
2.40	1510°F.
2.45	1530°F.
2.50	1505°F.
2.55	1520°F.
3.00	1485°F.
3.05	1530°F.
3.10	1505°F.
3.15	1500°F.

The temperatures reached in the cells of the hollow clay tile and cinder block were as follows:

CELL TEMPERATURE

Time	Clay Tile	Cinder Block
2.00	140°F.	115°F.
2.15	183°F.	140°F.
2.30	260°F.	160°F.
2.45	413°F.	260°F.
3.00	681°F.	384°F.
3.15	704°F.	397°F.

There was no passage of flame through, and no bulging or deflection of the walls or of the partition carrying a 10-ton load.

When the fire had continued 1½ hrs. and with an interior temperature of 1500° F., it was extinguished and the building completely saturated with water by the Reading fire department, with a sudden reduction of temperature to under 212° F.

The engineers subsequently examined the building and inspected each unit as the building was demolished. They report all of the walls free from bulging or deflection, and the Straub plock party wall loaded with 10 tons of iron was unaffected except on the surface. All of the materials were discolored either by smoke or water. Of the 637 Straub block, 2 were cracked, the remaining 635 uninjured beyond surface calcination to a maximum depth in a few cases of $\frac{3}{16}$ in. The clay tile were badly cracked and checked and unfit for use.

Of 91 exposed face brick in the north party wall, 85 were cracked and unfit for use.

As a direct determination of the effect of the fire and quenching upon the strength of Straub block, 5 were taken from various places in the structure after the test, and tested in comparison with 5 block of the same age taken from stock piles. The results were as follows:

COMPRESSION TESTS

Specimen No.	Block from Fire	Block from Stock Pile
	(Crushing Strength and lbs. per sq. in.—gross area)	
1	792.0	763.0
2	813.0	838.0
3	774.0	849.0
4	771.0	793.0
5	800.0	761.0
	Av. 790.0	Av. 801.0

Results show that Straub block, after exposure to fire for 1½ hrs. with a maximum temperature of 1540° F. followed by quick quenching by water, suffered no appreciable loss of structural strength, and that they still were capable of meeting the usual minimum crushing strength requirement of 750 lb. per sq. in.

Upon analysis, an average sample of the block was found to contain:

(PARTS BY VOLUME)

Cement	1.00
Cinders	6.13

"In length and intensity this test approximates the conditions of a destructive dwelling house fire, and their condition at the end shows cinder block to be strongly fire resistant and to be capable of passing through the average fire unimpaired, except for surface discoloration."

The fire test was put on because G. H. Muth, manager of the Berks Building Block Co., was meeting with serious competition from the clay brick people with heavy price cuts on the clay product.

The effect of the test from a business standpoint is reported as having been unusually satisfactory.

THE TEST STRUCTURE AFTER FIRE

Concrete Road Construction Methods

By C. C. Mason
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Paper Presented at Indiana Road School held recently at Purdue University.

Our specifications for 1923 and 1924 will not permit piling material on the sub-grade. This leaves it up to the contractor to use a central proportioning plant at the railroad switch, which is the ideal method, or to stock pile at convenient locations and use proper measuring devices to insure the correct amount of aggregates for each batch. From the engineer's standpoint, the use of charging bins with a measuring hopper at the bottom and the transporting of the aggregates in light trucks to the mixer on the sub-grade and placing the cement from stock pile directly into the mixer skip, is the best method. It gives the inspector an opportunity to check his cement factor and watch the mixing, placing, and finishing without leaving the mixer. With a uniform aggregate, the measuring hoppers will need very slight attention and adjustment.

When a central mixing plant is used, it should be so designed with measuring boxes or hoppers to insure the correct amount of aggregate and cement for each batch and will require an inspector to watch it. It is not desirable to have a lapse of time of more than 30 min. between mixing and placing. The mixed concrete is generally hauled in Ford trucks equipped with 30 cu. ft. dump beds, and requires two to four men to unload the concrete from the truck. This method has been used on one of our jobs, but requires a water line for curing unless the calcium-chloride method is used.

Steel forms should be used exclusively, and should be of a height equal to the thickness of the pavement. They should have a bearing surface on the sub-grade of not less than 48 sq. in. per lineal foot of form and weigh not less than 8 or 9 lb. per lineal foot. The forms should be well staked at intervals not exceeding 5 ft., and should be set in an absolutely straight line. It is necessary for the contractor to provide sufficient forms for a day and a half's run, in order that no form will be removed for at least 12 hrs. after placing. Forms should be set at all times at least 300 ft. ahead of the mixer, so the sub-grade can receive its final preparation without delaying the mixer.

The Mix

On one-course roads, both the State Highway Commission and Marion County are using 1:2:3 mix. The State specifies a cement factor of 1.7 bbls. of cement per cu. yd. of concrete, whereas Marion County specifies 1.75 bbls. for a stone aggregate, and 1.67 bbls. for gravel aggregate. For the purpose of checking the amount of cement used, it is customary to reduce this cement factor from barrels per cu. yd. to sacks per sq. yd. or per lineal foot of pavement. It is also necessary for the inspector to check the cement at intervals not exceeding a half-day's run, and when starting a job to check the cement every 10 to 15 ft. until the measuring boxes are adjusted to give the proper proportions as required by specifications.

It is necessary to use measuring hoppers or boxes that can be adjusted to secure the correct amount of aggregate necessary to meet the specifications. A measuring device attached to the bottom of overhead bins is the ideal method. Where Ford trucks are used, the method of nailing strips or painting lines on the truck body to insure the correct amount of aggregate, will give good results but requires the striking off of each truck load, first for the gravel and then for the sand. There is always a tendency to neglect the striking off of the truck loads on account of the time and labor involved, especially when the contractor is pushing the job. Unless each truck is struck off, there will be a lack of uniformity in each successive batch, some containing a little more aggregate, which is generally the case, and some a little less. While the cement may check at the end of a day's run, some spots will have more cement than others. The road is no better than the weakest spot. Uniformity of each batch of concrete is absolutely essential to secure a good, lasting pavement, and too much care can not be exercised by engineer, inspector, and contractor to secure these results.

Concrete should be mixed in a batch mixer for a period of not less than 60 sec. after all materials are in the drum, the mixer being operated at the number of revolutions per minute recommended by its manufacturer. The mixer should be equipped with a water-measuring device to insure a uniform consistency in every batch, and the amount of water used should be the least amount that will produce a workable consistency, as every pint of water beyond this amount reduces the strength of the concrete. The mixer should be equipped with a batch meter to register the number of batches poured. For a mixer operating on the sub-grade, the discharging device should be of the boom and bucket type. The consistency should be such as to show a settlement of not over 2 in. in the slump test.

The concrete should be placed only on a moist sub-grade, and should be spread the full depth and width of the pavement by shoveling. The use of rakes should not be permitted. Any manhole tops, railway tracks, or other structures should be brought to finished grade before the concrete is placed around them. Concrete should not be placed on a frozen sub-grade.

Finishing Concrete Surface

After placing, the concrete should be struck off, tamped and finished by a finishing machine, so designed as to move either backward or forward and at such speed as to thoroughly compact the concrete and eliminate all voids. The machine should go over the concrete a sufficient number of times, and at such intervals as will give the desired results. The strike board should cut the concrete at least ⅜ in. high to allow for tamping, and must conform to the required cross-section of the pavement. Forms and wheels of the finishing machine should be kept clean and free from dirt at all times.

On curves, widened portions of the pavement or in such other cases as the engineer may direct, hand tamping and finishing should be substituted for the mechanical.

The concrete should be struck off by means of an approved template and should be thoroughly compacted with a hand tamper, meeting the approval of the engineer. Immediately after the concrete has been tamped, it should be rolled with an approved metal hand roller, having a smooth, even surface, approximately 6 ft. in length, 12 in. in diameter, and weighing not more than 1 lb. per in. of length. The roller should be used just as soon as possible without displacing the concrete. In warm weather, especially with rock aggregate, if the concrete has not been mixed too wet, the roller may be used immediately. In cool weather, it may be necessary to delay the first use of the roller for 30 or 40 min. If the pavement is not over 20 ft. wide, the roller may be operated from one side of the road to the other, by a long handle.

If the pavement is much wider than 20 ft., it will be found more convenient to attach a rope to the roller and pull it from one side of the pavement to the other, discarding the handle entirely. In this way, it is possible to roll with greatest facility any width of pavement. The roller should always be moved transversely across the road at a small angle, so that it will move lengthwise of the road about 2 ft. each trip across. After the first rolling, the same area should be gone over again in about 15 or 20 min. The concrete should receive successive rollings at intervals of 15 or 20 min. until little or no free water is squeezed out. This usually requires not less than 3 rollings, depending upon the amount of water with which the concrete has been mixed, and also on the temperature. The less the amount of water and the warmer the weather, the fewer the number of rollings required.

After the rolling has been completed, the pavement should be finished by two applications of a belt made of canvas or rubber belting, not less than 6 in. wide and not less than 2 ft. longer than the width of the pavement. The belt should be applied with a combined crosswise and longitudinal motion. For the first application, vigorous strokes, at least 12 in. long, should be used, and the longitudinal movement of the belt along the pavement should be very slight. The second application of the belt should be immediately after the water glaze or sheen disappears, and the stroke of the belt should be not more than 4 in., and the longitudinal movement should be much greater than for the first belting.

The edges of the concrete pavement should be rounded with an approved edging tool, having a radius of not more than 1 in. The edges at expansion joints should be rounded with a tool having a radius of not more than ⅜ in.

The finished surface of the pavement should be true and even. The contractor should be required to test the surface with a 10-ft. straight-edge placed on the wet concrete parallel with the center line of the pavement. This straight edge should be applied to the center line and quarter points, and must touch the concrete at all points. Any high places should be cut down and any low places filled up until the finished pavement has a true and uniform surface. In finishing the pavement, this straight-edge should be so placed as to lap the finished surface at least 3 ft. Special care should be used at each expansion joint to insure a smooth surface on both sides of the joint. The straight-edge should be centered on such joints.

Too much emphasis cannot be placed upon the importance of the use of a straight-edge, because this method insures a trueness and evenness of surface of pavement not otherwise obtainable.

CURING OF CONCRETE SURFACES

After the concrete surface has been finished, as described above, it should be protected by applying burlap very carefully. The burlap should be placed as soon as possible after finishing, without marring the surface. This does not mean that the concrete would have to be anywhere near the final set. After the burlap has been placed, it should be kept wet by sprinkling with a fine spray of water until the concrete is sufficiently hardened to remove the burlap and place on the other curing material. The burlap should weigh at least 12 oz. per sq. yd., and be in strips 40 in. wide and 2 ft. longer than the width of the concrete to be covered. At the ends of the strips should be fastened either iron bars or wooden strips, so as to prevent raveling and aid in handling them.

As soon as the burlap covering is removed, the surface should be covered with straw to a depth of at least 3 in. The straw should be thoroughly wet, and kept moist by sprinkling with water for a period of at least 20 days, under favorable weather conditions, and longer if the engineer so directs, during which time all traffic should be kept off the concrete by the erection of suitable barricades and maintenance of same.

On level stretches of pavement, the concrete may be cured by building suitable earth dykes to such height as will permit the entire pavement to be covered with water to a depth of not less than 2 in. The water should be maintained at this minimum depth for a period of at least 20 days. This method is very effective, but can be used only on comparatively level grades.

Another method of curing is to use not less than 2 in. of earth covering instead of straw. The same restriction as to sprinkling for 20 days applies to this method.

The use of calcium chloride is comparatively new, but its use eliminates the necessity of a water line where a central mixing plant is used. When used, the surface of the concrete, after the removal of the burlap, should be uniformly covered with not less than 3 lb. of granular or flake calcium chloride per sq. yd. of pavement. This treatment should not be applied under 8 hrs. after finishing, and preferably 16 hrs. The treated surface should be protected from rain for a period of at least 12 hrs., or additional applications should be made following rains, to insure 3 lb. of calcium chloride per sq. yd. of surface for a period of at least 12 hrs.

Expansion joints should be provided by placing permanently in position, a preformed, solid body of compressible, asphaltic compound reinforced on both sides with a high grade, asphalt saturated wool felt, for the full depth thereof. The joint filler should be a suitable bitumen which will not become soft enough to flow in hot weather or brittle in cold weather.

Our practice in Marion County has been the use of an expansion joint 1 in. in width placed across the pavement perpendicular to the center line of the road at the end of each day's run. All expansion joints should extend the full depth of the pavement. Edges adjacent to the joint should be rounded to a radius of not more than ¼ in. with a suitable tool.

Dowels of ¾ in. round rods 4 ft. long should be used at each expansion joint. These dowels should be placed on 3-ft. 6-in. centers, and should extend 2 ft. into each slab. The 2-ft. length of the dowel placed at the time of quitting work should be wrapped in heavy paper to prevent bonding. The next morning these dowels should be pulled out about 2 in. to allow for expansion. The other half of the dowel should be bonded in the slab. It will be necessary to have holes bored in the night board to facilitate placing the dowels.

It has been the practice in Marion County during the last four years to specify 40 lb. of steel reinforcing per 100 sq. ft. of pavement. However, beginning with 1923, we adopted the Illinois standard, using a ¾-in. round bar, not bonded, with a steel contraction joint on the center line of roadway. We are also using ½-in. dowels 4 ft. long spaced on 5-ft. centers through the contraction joint to tie the two halves of the slab together. These dowels are bonded.

Concrete should not be mixed nor deposited when the temperature is below freezing. If, at any time during the progress of the work, the temperature is at, or in the opinion of the engineer would, within 24 hours, drop to 35° F., the water and aggregate should be heated, and precaution taken to protect the work from freezing for at least 10 days. In no case should concrete be deposited upon a frozen sub-grade.

How to Get Uniformity in Road Concrete

By W. W. Zass
Arkansas State Highway Dept.

In the logical sequence of operations the following factors are believed to be conducive to the great lack of uniformity in strength noticeable in concrete pavement slabs:

(1) Failure to adopt scientific proportioning of materials.

(2) Failure to measure accurately proportions for batches.

(3) Non-uniform water content.

(4) Method of depositing concrete from mixer drum to sub-grade.

(5) Curing.

(6) Weather conditions.

(1) Failure to adopt scientific proportioning of materials. The majority of projects today still retain specifications calling for arbitrary mixtures, regardless of the grading of the coarse aggregates used. Such arbitrary mixtures are manifestly wrong, as most aggregates, especially pebbles, vary in grading from time to time. Investigation of scientific proportioning has progressed to a stage whereby accurate results can be predicted and obtained in the field under intelligent supervision.

(2) Failure to measure accurately the proportions for batches. Materials for each batch should be measured separately and accurately by a measuring device, and not by marks or nails in the body of the vehicle. This point is generally neglected when aggregates are loaded from stock pile to vehicle by hand. A variation of one-half tenth foot in height of the fine or coarse aggregate in a 3 x 3 ft. batch box will change a 1:2:3 mix to either a 1:1.9:3.1 or a 1:2.1:2.9 mix. Overloading or underloading will also vary the specified proportions accordingly.

(3) Non-uniform water content. This point has been stressed so often and so emphatically that little more remains to be said. Practically, this feature can be controlled by measuring the water content for each batch, specifications generally cover this item in detail. Variations in the moisture content of the aggregate will cause some difference in the quantity of water needed per batch of concrete, but this point can be controlled by intelligent supervision in the field.

(4) Method of depositing concrete from mixer drum to sub-grade. In order that the results of ideal proportioning and thorough mixing may not be lost, the entire batch should be deposited in place in one operation. This result may best be accomplished with mixers of the boom and bucket type, rather than with mixers which require chuting. With the latter type of mixer, the coarse materials are separated from the mortar, and almost invariably certain portions of the slab will contain more mortar and less coarse materials than others.

(5) Curing. Research has shown that proper curing is as essential as proper proportioning. Non-uniform curing is certain to produce non-uniform results in strength ratios. Many times a great variation is noticeable in curing operations on different portions of the same project. Great delay is sometimes experienced in starting the curing operations, again, they progress smoothly and swiftly. The slab will be well covered on one portion and but scantily on another, also the covering will be kept well saturated on one portion and but poorly watered on another.

(6) Weather conditions. A great lack of uniformity is attributable to this factor. A 70° variation in temperature is not uncommon from the time a project is started until the time it is finished, and a 40° variation may easily occur during a single day's pouring. Variations in humidity are relatively as great. Research has shown that the compressive strength of concrete is dependent upon the rise or fall of temperature during the period of setting.

While, to our minds, the six items as enumerated above are the most essential, they are by no means all of the factors which may tend to cause variations in strength of concrete pavement slabs. There are but few operations in paving which do not have an important bearing on the final result. In addition to the six items already mentioned, we believe the four following items should also be classed as having an important bearing on the uniform strength of concrete slabs:

(7) Variation in brands of cement used.

(8) Variation in moisture content of subgrade during and after pouring.

(9) Insufficient tamping.

(10) The difference in bulking due to moisture content of sand when aggregates are measured by volume.

(7) Variations in brands of cement used. Due to combination of circumstances, different brands of cement are often used on the same project. Tests have shown that different cements vary considerably in strength ratios.

(8) Variation in moisture content of sub-grade. A damp sub-grade will tend to prevent the rapid drying out of the concrete. Owing to weather conditions at time of pouring, the sub-grade will be dryer on some portions than on others. Again, during the succeeding curing period, soil and weather conditions will determine the extent of moisture reaching the under side of the slab.

(9) Insufficient tamping. To obtain a dense, well-compacted concrete, sufficient uniform tamping is necessary. This result can be secured by means of mechanical tamping, rather than by hand tamping. This point is well recognized, although some specifications fail to cover it.

(10) The difference in bulking due to moisture content of sand when aggregates are measured by volume. Investigation has shown that considerable variation exists in the bulking capacity of sand when same is measured wet or dry. This variation would naturally affect the specified mix, either increasing or decreasing the volume of aggregates used per unit volume of cement.

Conclusions

A review of the various items outlined above will indicate that the several factors, indicated as affecting the strength of concrete pavement slabs, can be roughly divided into three groups; there is no hard and fast line separating these groups, each group merging from one into the other:

Those factors which can be wholly controlled by means of specifications—in this group we might place Nos. 1, 2, 3, 4, 7, and 9.

Those factors which can be only partly controlled by means of specifications—in this group we might place Nos. 5, 8, and 10.

Those factors which it is impossible to control by means of specifications—in this group we might place No. 6.

Those factors which can be controlled in part or not at all by means of specifications are susceptible to control to a considerable extent by means of field inspection, and upon this form of control we are forced to depend.

For those factors which can be controlled wholly by specifications, we recommend:

That existing specifications be revised as soon as practicable, incorporating the following features where such features are not now so covered.

Eliminating arbitrary concrete mixtures in favor of scientific proportioning.

Eliminating the measurement of aggregates by means of nails or marks on the body of the vehicle in favor of independent measuring devices.

Eliminating the chute type of mixer in favor of the boom and bucket type of mixer.

Eliminating hand tamping in favor of mechanical methods of tamping.

That a further study be made in order to determine:

Practical and economical means of controlling the variations in moisture contents of sub-grades due to weather and soil conditions.

Practical and economical means of taking into consideration the difference in bulking of wet and dry sands.

"Mineralized Sawdust" Aggregate for Concrete

Novocrete, to which brief reference has already been made in this magazine, is a new kind of concrete, with mineralized sawdust as an aggregate, which has many interesting possibilities. The Novocrete Co., 522 Fifth Ave., New York City, supplies a report of tests made by Columbia University, New York, by Messrs. Henry J. Faija Co., at its portland cement testing laboratory, London; and by R. H. Stanger, at his testing works, also in London; and some few experiments made by the Novocrete Co. itself.

The quality of the resulting material is dependent to a considerable extent upon the character of the sawdust, some of the things to be avoided being a high percentage of wood flour. Some of the tests made at Columbia employing common, ungraded soft-wood sawdust, of which 30 to 40% passed through a No. 40 sieve, gave a tensile strength at 7 days of 243 lb. per sq. in., and at 28 days of 260 lb. per sq. in., this sawdust having been mineralized with mineralizing solution No. 1, the mixture having been made of two parts mineralized sawdust to one part Atlas cement. Other grades of sawdust gave 28-day strengths ranging from 353 lb. to 493 lb.

The chemical used in the mineralizing solution has a fireproofing effect, which increases as the percentage of chemical used in the solution increases. Experiments were made to ascertain whether the tensile strength of the Novocrete was reduced by the mineralizing solution. It was found that by using a 5% solution of No. 2 mineralizing liquid that the tensile strength of a 1:2 mixture was 386 lb. per sq. in.; using a 10% solution, the tensile strength was 375 lb. per sq. in.

Experiments were also made to learn the effects on tensile strength of Novocrete by adding various percentages of lime. Briquets with no lime at 7 days tested 320 lb.; with 22% of lime, 243 lb.; with 33% of lime, 246 lb.; with 66% of lime, 167 lb. To find out whether or not the mineralizing solution reduced the strength, tests were also made, comparing the tensile strengths of briquets made of cement and water, and those made with cement and No. 2 mineralizing liquid, omitting the sawdust. Briquets made with cement and pure water tested 339 lb., and those made with cement and mineralizing liquid tested 358 lb.

2 x 4-in. cylinders of Novocrete were made by Columbia University for testing in compression using the same kind of common, ungraded sawdust used for briquets. The sawdust was mineralized by the University authorities with mineralizing liquid, No. 1 solution, and the cylinders were made with two parts of mineralized sawdust to one part Atlas cement. Cylinders were stored in a damp closet until tested. The results at 7 days were 1030 lb. per sq. in., average of three cylinders, and at 28 days 1540 lb. per sq. in., average of three cylinders. At the same time, cylinders were made with the same sawdust and with the same portion of cement, the sawdust unmineralized. These cylinders showed 15 lb. strength at 7 days, and 54 lb. strength at 28 days. Absorption tests of Novocrete were carried on according to the specifications of the American Concrete Institute for concrete building units, which provide that "concrete block and tile shall not absorb more than 10% of the dry weight of the unit when tested, except when made of concrete weighing less than 140 lb. per cu. ft. In every block or tile made with concrete weighing less than 140 lb. per cu. ft., the absorption percent by weight shall not be more than 10 multiplied by 140 and divided by the unit weight in lb. per cu. ft. of the concrete under consideration." On this basis, with the dry weight for Novocrete of 70.5 lb. per cu. ft., using two parts of mineralized sawdust, fine and ungraded, and one part of cement, showed absorption ranging from 6.5 to 7%.

In making some of the specimens, a few samples were produced as for a troweled floor, and the results show clearly that in laying a floor and troweling it off, a much less dense Novocrete is obtained than when a Novocrete specimen is made in a mold and the mixture rammed.

Tests made of the wearing qualities of Novocrete, using 1-in. cores drilled from precast slabs of Novocrete and of 1:2 sand and cement at 28 days old, showed a comparative loss in cu. cm. from Novocrete of 2.34 cu. cm., as against 7.98 cu. cm. for sand and cement; 2.14 cu. cm. for Novocrete for 169 revolutions in the machine; and for sand and cement for 210 revolutions in the machine 9.14 cu. cm. loss; whereas Novocrete, with 500 revolutions in the machine, lost 6.32 cu. cm.

Transverse bending tests were made with samples 2 x 12 x 24 in. on a span of 22 in., with loads from 23 lb. to 806 lb. Center deflection varied from .0006 at 39 lb. load up to .0386 lb. at 739 lb. load. Specimens showed modulus of rupture 537 lb. per sq. in.

Permeability tests were made under hydrostatic pressure on specimens 1 x 4 x 4 in. at 28 days. Pressure at 15 lb. per sq. in. for 15 minutes showed water through the slab; while with 5 lb. pressure per sq. in. for 5 minutes there was no moisture on the exposed surface; 10 lb. pressure per sq. in. for 2 minutes let water through the slab. Two different specimens were involved in this test.

Fire tests were made in which samples of Novocrete 2 x 5 x 5 in. 28 days old, made of two parts by volume of mineralized sawdust to one part of Atlas cement placed in a coal-gas furnace, the temperature gradually raised to 700° F. in one hour, and the furnace turned off, at the end of which exposure one specimen was plunged into water at room temperature and the other allowed to cool slowly in air. The specimen cooled in water was intact after the test and had sharp edges, although the surface was somewhat checked. The surface was softened to the depth of $\frac{1}{16}$ in. The sample cooled in air softened to a depth of about $\frac{1}{8}$ in., and the two older samples cooled in water and also in air were both intact, had sharp edges, and both had softened to a depth of about $\frac{1}{8}$ in. Comparative fire tests were made with gypsum hollow partition tiles, specimens in each case being 3 in. thick, 12 in. wide, and 30 in. high, the Novocrete tile being perforated longitudinally by five cylindrical ducts each $1\frac{5}{8}$ in. in diameter, the gypsum tile having four longitudinal ducts each $1\frac{3}{4}$ in. in diameter. The Novocrete tile were made with four parts by volume of mineralized sawdust to one part of portland cement, and were 20 days old at the time of test. The gypsum tile were more than a year old. Both tile were subjected to gas fire for one-hour test, in accordance with the requirements of the building code of the city of New York. The temperature of the gas furnace was raised from room temperature to 1700° F. in one half-hour and maintained slightly above that temperature for another half-hour. Both tile were then removed from the furnace, and the faces of both exposed to the fire were still red hot when they were subjected for 30 seconds to a garden hose stream of cold water. The portion of the Novocrete partition tile exposed to the fire was discolored and rendered friable to a maximum depth of $\frac{3}{4}$ in., the balance of the tile being sound and unaffected by the test. The gypsum tile was discolored and rendered friable to a maximum depth of 1 in.

To compare the contraction of Novocrete setting in air with the contraction of sand and cement under similar conditions, and to measure the effects of immersion in water on both kinds of specimens, tests were also made. These showed that the coefficient of contraction of Novocrete is twice as much as the coefficient of contraction of the sand and cement sample during the hardening period of the two samples. Both samples were then immersed in water, and at the expiration of four days the results showed a greater coefficient of sand and cement than of Novocrete.

Warping tests, tests with color mixtures, and tests for the protection of steel were also made and reported on by Columbia University.

To ascertain the compressive strength of Novocrete bricks, a series of experiments were made, using sawdust free from wood flour. The results of the experiments are shown in the following table:

Tests Made on Novocrete Bricks $8 \times 4 \times 2\frac{3}{8}$ in.

Mixture Used	Age of Brick Days	Compressive Strength Lbs. per sq. in.
3 parts mineralized flaked sawdust........ 1 part cement	36	1680
3 parts medium coarse mineralized sawdust 1 part cement	29	1870
3 parts coarse mineralized sawdust........ 1 part cement	29	1400
4 parts coarse mineralized sawdust........ 1 part cement	29	1200
5 parts coarse mineralized sawdust........ 1 part cement	29	590

All the Novocrete samples tested for compression were hand made.

Schools That Will Not Burn

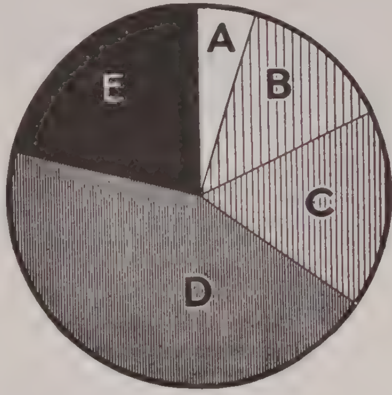
The relative fire safety of public schools is shown in the accompanying diagram, based on an investigation directed by the National Committee for Chamber of Commerce Cooperation with the Public Schools and the American City Bureau. To gather the statistics given below, 7150 school buildings in 429 cities were investigated. For the diagram, CONCRETE is indebted to the General Fireproofing Co.

The investigation showed our schools to be constructed as follows:

Type A—A building constructed entirely of fire resistive materials, including its walls, windows, doors, floors, and finish. Only 5% of our schools are in this class.

Type B—A building of fire resistive construction in its walls, floors, stairways, and ceilings, but with wood or composition floor surface and wood roof construction over fire resistive ceiling. Only 13% of our schools are in this class.

Type C—A building with masonry walls, fire resistive corridors, and stairways, but with ordinary construction otherwise, i. e., combustible floors, partitions, roofs, and finish. Seventeen per cent of our schools are in this class.



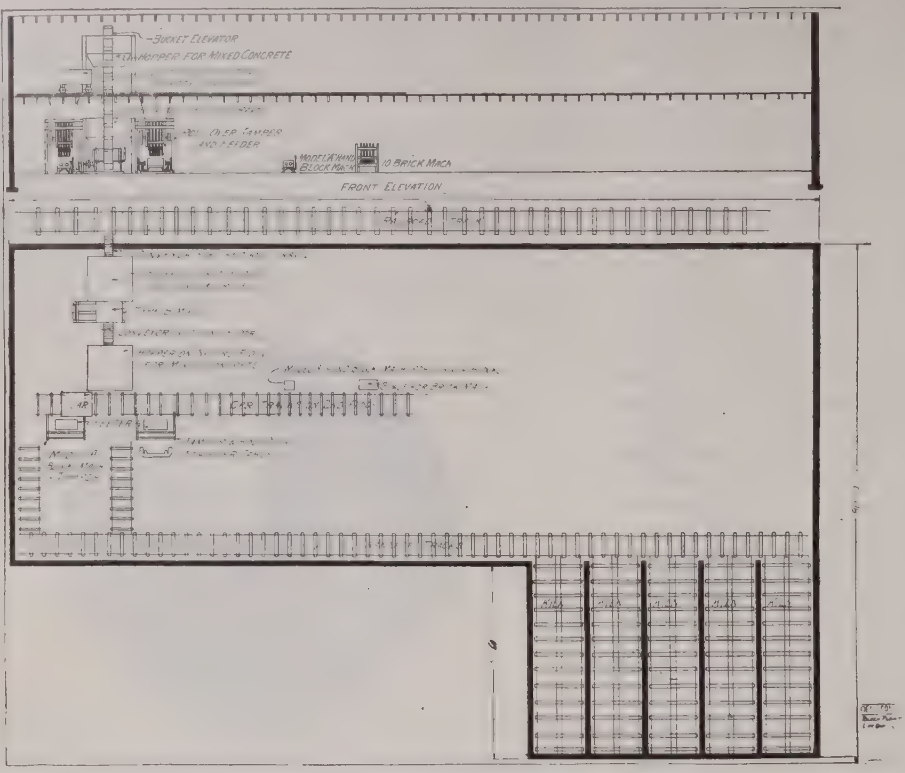
Type D—A building with masonry walls, but otherwise ordinary or joist construction and wood finish. Forty-four per cent of our schools are in this class.

Type E—A building constructed with wood above foundations, with or without slate or other semi-fireproof material on roof. Twenty-one per cent of our schools are in this class.

These facts bring home the necessity of building schools that will not burn.

A Short Cut in Handling Concrete

During the construction of the Barge Canal in New York State, a contractor made use of a large centrally located mixing plant from which to transport the wet concrete to various points, transportation being accomplished by means of several trains of small cars drawn by locomotives. No trouble was experienced in depositing the concrete at points near the mixing plant, but at distant points, due to the time the concrete was in transit, there was serious trouble. In the latter case, the wet aggregate became so firm that no amount of jarring and reversing of the cars would dislodge it. Pounding the steel sides of the cars with heavy sledges and using picks and shovels on the surface of the concrete was the method of the laborers in dislodging it. When it seemed impossible to remove the concrete without ruining the cars, other expedients were tried, but none remedied the condition so well as a loose platform of boards placed in the bottom of each car. The purpose of this platform was to allow water to collect under the mass of wet concrete instead of on its surface. It was found in using this platform that the water underneath it worked along the sides of the cars when they were reversed and caused the whole mass of wet concrete to be deposited easily. This short cut saved considerable time and labor, and prevented further destruction of the contractor's equipment.



PLAN OF PLANT OF BUFFALO WASH TRAY WORKS

Wash Trays and Building Units in Same Plant

Many manufacturers have failed by having too many concrete products lines. A successful combination of wash trays and block is interesting.

Some years ago, M. J. Deutsch, president of the Buffalo Wash Tray Works, of North Tonawanda St., Buffalo, N. Y., undertook the manufacture of wash trays in conjunction with the production of concrete block, with which he had had experience for 20 years. After the wash tray business had developed, he moved from Connecticut to Buffalo, and established The Buffalo Wash Tray Works. Pushing this enterprise with unusual energy, he soon brought it to a point where he was shipping wash trays in carload lots all over the country. By that time, the wash tray business had grown until it almost filled the building in which he was located—to the exclusion of the block business—although previously he had been operating an Ideal power outfit and devoting as much space to the block department as his comparatively limited quarters would allow.

Shortly after the war, Mr. Deutsch purchased a plant, which he now occupies, and which had been used for the manufacture of various materials. This plant is sufficiently large to accommodate the different lines of his business, and Mr. Deutsch is now making wash trays and concrete building units all in one section of the building, having sufficient room for a well-laid-out concrete block plant and yard. He employs a salesman on the road, full time, and due to the company's active merchandising and the quality of his block, in excess of 2000 block a day are being sold.

Mr. Deutsch says that for some time he had considered conditions under which block were being sold in Buffalo, and concluded that if a manufacturer turned out a first-class product and pushed its sale in the same way that he had pushed the sale of wash trays, an excellent business could and would be built up.

The plant is laid out to manufacture block with a minimum of labor. As shown in the layout, the railroad cars discharge directly outside the plant, and the pit conveyor carries the sand and gravel to an overhead hopper. This hopper discharges directly into a mixer, after which the concrete is carried into an elevated hopper, from which it is distributed by hopper car to the various machines. At present, the plant contains one Ideal face-down machine with tamper and core puller; one Ideal roll-over stripper outfit, both of which are equipped with Ideal material feeders and an Ideal hand block machine for the manufacture of corners and specials. Plenty of space is allowed in the block plant for additional machinery as the business grows. The car tracks are so arranged that they come directly between the two machines, and therefore may be loaded with minimum labor. The transfer track runs the entire length of the plant, so as to serve all the machines that will be installed later. The curing rooms at one end are of ample size to care for the daily output and connect at the opposite end directly with the block yard.

The plant is being run with the following crew: one man on the mixer, one man attending to the distribution of concrete to the machines, one operator, one off-bearer on the face-down machine, and either one or two off-bearers on the roll-over, depending upon whether 8-in. or 12-in. block are being made.

The plant layout is flexible and can readily take care of the particular product as the trade demands.

Location of a Concrete Building Unit Plant

A man about to go into the business of manufacturing concrete building units has—if he anticipates any large or lasting success—to find the answers to many questions, all having a bearing on his proposed enterprise. A recent article in CONCRETE, by William F. Lockhardt, went into this matter in considerable detail, and prompted another contributor along the same line.

The Philadelphia office of the Portland Cement Association, L. N. Whitcraft, district engineer, has been very active in the study of products manufacturing, as there have been big developments in such enterprises in that territory. Field studies with prospective manufacturers resulted in compiling a list of questions and subjects for investigation which should be considered carefully before investing in a products plant. Here is the "questionnaire on location of products plants:"

QUESTIONNAIRE ON LOCATION OF BUILDING PRODUCTS PLANT MARKET

1. Give population of city; of suburban community. What radius will include the above groups; percentage of native whites in each of above groups. Are the majority of homes owned or rented by occupants?

2. What is the present annual volume of residential construction; of industrial construction; within the city limits; within the suburban community? How do these figures compare with normal?

3. Is there a shortage of houses or is the supply adequate? If inadequate, give reason for failure to build.

4. What are the prevailing types of residential construction; industrial construction?

5. Is stucco popular type of dwelling? Is there any local condition, such as excessive coal dirt or local prejudice, against the use of stucco?

6. Give approximate percentage of dwellings built under architectural supervision, by speculative builders and by carpenter contractors. If possible, separate as follows: Less than $5000 in cost; $5000 to $10,000; $10,000 to $20,000; over $20,000.

BUILDING MATERIALS

1. What is the present price of common clay brick, hard red brick, stretcher brick, face brick, hollow clay tile, building stone, concrete block or tile, other masonry units, structural lumber, siding lumber, flooring lumber, cement, sand, stone or gravel, slag, lime, coal, hard coal, steam cinders, soft coal steam cinders?

2. Give location of principal sources of each of the above materials.

3. Which of the above are available in abundant, moderate, or small quantities?

LABOR

1. Is the supply of brick masons adequate; stone masons and helpers, carpenters, plasterers, hod carriers, common laborers? How does the present supply compare with normal?

2. What are the prevailing wages for each of the above trades? How does this compare with normal?

3. What is the prevailing race in each of the above trades?

4. Which of the above, if any, are highly organized? Unorganized?

5. Do brick masons lay up masonry walls other than brick? If not, who does?

6. Has there been any action taken by local brick masons against the use of masonry units, other than clay brick?

7. What influence, if any, do local materials producers have with organized labor?

8. How many brick is an average day's work, per mason, on a 9-in. residential wall?

9. In which trades are strikes most prevalent?

BUILDING CODES AND OFFICIALS

1. Is there a building code in the city? Outside the city? (Secure copies of these codes.)

2. If so, of what materials may residential walls be constructed within the fire limits; within the city limits outside of the fire limits; outside of the city; party walls? Give required thickness and height for the various materials in each of the above classifications.

3. Of what materials may walls in industrial buildings be constructed; bearing walls; non-bearing walls; fire walls; party walls? Give required thickness and height for each material for each of the above classifications.

4. If no code exists, what are the recommendations of the building department in regard to the above?

5. If no building department exists, what restrictions are placed upon building construction by local ordinances; by county ordinances; by state laws or rulings?

6. Give size of organization of building department; salaries of principal executives and other gainful occupations of interests of principal executives.

7. Is there any evidence or indication of partiality on the part of the building department towards any material or building trade?

TRADE CONDITIONS

1. What is the prevailing rate of discount and time allowance for this discount? What is the customary credit period?

2. Are the building contractors carried by trust companies, building and loan associations, material producers, or private capital? Is there any indication of preference on the part of money lenders for any particular type of construction or material?

3. Are materials habitually sold direct or through dealers? What is the standard dealer's differential?

4. Are dealers equipped to make deliveries or do the local producers deliver their own materials?

MANUFACTURING CONDITIONS

1. List the available sites of about one acre in area which are located on railroad sidings and through paved streets. Give purchase or rental prices and locations. Mark the proposed locations on a map. State if sites are vacant, or if existing structures must be demolished. Give estimate of cost of this work and other improvements necessary.

2. Is there a transfer or switching charge by the railroad from the main line to the proposed site?

3. What is the haul by truck from each site to the center of the proposed trading area?

4. If possible, secure map showing hard-surfaced paved streets and highways within trading areas. If map is not submitted, give description of paving conditions within the city, outside the city.

5. Is electric power available and at what price? Give distance from main line and cost of feeder of each of above sites. Is steam available? Give distance cost and working pressure.

6. Is there any local prejudice against outside enterprises entering the field?

7. Give transportation cost and method for building materials, such as cement, sand, stone, and cinders, from the source to the several plant sites.

A Central Mixing Plant in Los Angeles

The central concrete mixing plant of the Uniform Mixed Concrete Co., Inc. (formerly Stine and Ellis, Inc.), at 1000 La Brea Avenue, Los Angeles, is an innovation for the West. It appears that this is the pioneer central mixing plant in the West, operated for public use, and represents an investment of $25,000, has a capacity of 365 cu. yds. of mixed concrete every 8 hours, a battery of 4 big rock hoppers, and a 9-sack Smith tilting mixer, all operated by electricity.

Since the completion of this plant, two others have been erected within a radius of 50 miles, from the same design; and plans are being prepared for the building of 2 more. Ready mixed portland cement concrete in quantities sufficient for a flagpole foundation or a 12-story building, and delivered right on the job when required, was something apparently that Los Angeles needed, and the company reports a rushing business, notwithstanding a slight building depression.

Both Mr. Stine and Mr. Ellis are experienced concrete men. They tried out their central mixing plant ideas in the execution of a contract previous to the building of the unit at Santa Monica and La Brea, this contract being for the laying of concrete on the coast highway between Santa Barbara and Gaviota.

They had at that time a plant at Tejiguas—rather a crude affair—composed of a highway paver, sufficiently elevated to allow direct discharge into 5-ton dump trucks, and fed by a wheelbarrow crew. These 5-ton trucks with their hard tires, and carrying 2½ yds. of mixed concrete, proved impracticable, causing segregation. However, by keeping close track of their expenses, it was found that they saved money on this work, despite their inadequate equipment, as compared with the usual highway procedure, the saving being effected by the elimination of waste, in the number of laborers required, in hauling—especially the hauling of cement—and in overhead, such as spotting and caring for materials on the grade, etc.

In short, they became sold on the idea of a commercial stationary concrete mixing plant, in other words, a concrete store, where anyone might purchase ready-mixed concrete in such quantities as desired. Having studied the situation from all angles, the New Uniform Mixed Concrete Co. was incorporated and the plant erected on La Brea Avenue.

The plant is so arranged that guess work is eliminated, every aggregate being accurately measured by the batch-box system. The aggregates are washed before coming to the plant, then dumped in concrete pits, thereby making certain of the absence of dirt. They are then elevated 80 ft. and deposited in 5 separate bunkers—4 rock bunkers and 1 sand bunker.

The mixing is done entirely by formula; the mixer operator doesn't see the mix.

Two sizes of screened rock are carried and two sizes of crushed rock; and in order to fill any order that might come in, the concern has run as many as 32 separate jobs in one day, with practically every different class of mixture.

The company's product, having been tested, has been approved by the Board of Public Works of the City of Los Angeles, and, at the present time, is being used on the streets of the city. The list of customers includes the following: The Standard, Union, and Associated Oil Companies; Peerless, Hollywood, and Community Laundries; Lasky, Keaton, and Vitagraph Studios; Gay Engineering Corporation; City of Beverly Hills.

The product has also been purchased by contractors, home builders, machinery dealers, plumbers, by the County of Los Angeles on boulevard patch work.

The company's plant includes a number of patented features. The company is using 16 Reo dump truck bodies and 4 Fords.

Can Dealers Sell Pre-Mixed Concrete?

By Charles H. Miller

From a paper to The Associated General Contractors of America.

The possibility of retail dealers preparing and selling ready mixed concrete is no longer a question. Central mixing plants have been established in a number of communities and have proved commercially successful. Wherever these plants are in operation, sales of cement and aggregates have been increased through the ability of the builder to buy his concrete ready-mixed and without the annoyance and inconvenience of mixing his own material.

The outstanding factor in the use of pre-mixed concrete is the time limit allowed for placing it into the forms after the mix. In Illinois, the State Highway Commission has decided that 40 minutes is the maximum that the concrete mix should be held in abeyance before being placed. In the State of Wisconsin, this time is stretched to 45 minutes. These time limits are based on the fact that the initial set takes place very soon after a thorough mixing of the concrete and aggregates.

Tests carried out by Professor Abrams of the Structural Materials Research Laboratory, though far from being complete, indicate there is no appreciable loss in strength of concrete that has stood for a period of 3 to 4 hours.

"There is apparently no objection to a central mixing plant from the standpoint of the effect upon the concrete," stated Professor Abrams. He says further: "It will be found as a matter of practical handling that considerable attention will have to be given to the consistency of the concrete, in order to prevent separation of water on the one hand and the concrete from becoming too much compacted on the other."

This represents the real problem for a commercial plant. If a plant were destined to operate on the same consistency day in and out, the problem would be materially simplified.

Sloppy concrete is absolutely taboo. The finished mix must be of a stiff, quaky consistency. A sloppy mix would have a tendency to cause separation of water from materials, and would also give trouble in ejecting the concrete from the truck into the receiving forms.

With the extension of the limit between mixing and placing, retailers will be permitted, with their commercial mixing plants, to haul pre-mixed concrete a considerable distance into farming communities and to other places where jobs would go ahead if the so-called nuisance involved in mixing concrete by laymen could be eliminated. All central mixing plants are not using bulk cement, but there is no reason why they could not so equip themselves as to have this commodity gravitate from a bin at the top of the plant to the mixer, the same as the stone, gravel, sand and water.

Information collected by the Portland Cement Association under date of June 15, 1923, indicated that they were able to find only six central mixing concrete plants operated solely as commercial propositions. There were at the same time, however, quite a number of such plants being operated by contractors on road work.

The first known central mixing plant to be erected in Canada and the United States for commercial purposes is located at Kankakee, Ill., and is owned and operated by the Shidler Construction Material Co. With the outfit in use at this plant, the dealer is in a position to give the purchasing customer any mix that he may desire. The method of proportioning the cement, stone, sand, and water is such that it is just as convenient to change the mix with each turn of the mixer as to run continuously on a given specification.

There is a decided advantage to the builder in the use of pre-mixed concrete. The builder appreciates the fact that there is no congestion of materials scattered around the job, either during or immediately following the work. A contractor can go ahead and get his above-grade materials in place while the forms are being filled. There are no piles of sand, stone, or sacked cement to interfere. When the concrete is placed, that part of the job is finished, and there isn't a remaining sign of any material or dust in the neighborhood of the job.

There are many jobs in every community that contractors would develop if it were not for the fact that they are too small in size to warrant the removal of the mixer. In the use of pre-mixed concrete, this is not necessary, and where a central mixing plant is in operation, the contractor can conveniently accept work of this nature. At other times, a contractor's mixer may be busy on the job when he desires to start with a second crew on another. The use of pre-mixed concrete solves the problem.

In the operation of a central mixing plant, there are three points of importance that should receive the constant attention of the individual in charge of the plant. They are:

1. Careful attention to proper gradation of aggregates. Whenever necessary, changes should be made.
2. Sufficient amounts of water must always be used, but never a surplus of water.
3. Proper mixing of the cement, water, and aggregates, and enough of it.

A measuring device, such as the Blaw-Knox adjustable measuring batcher, does away with the necessity of having to depend upon a workman to see that the measuring boxes are always filled up to a certain line. These measuring boxes can be adjusted to a fraction of a cubic foot, so that both the dealer and the purchaser know that they are furnishing and obtaining exactly the volume of each class of material that is desired in the mix. In cases where bulk cement is used, one man can easily handle the entire job of charging the mixer and of delivering the mixed concrete into the truck provided for hauling it to the job. Every batch exactly the same is absolutely assured after the measuring devices are once set where desired. Specifications are being drawn closer all the while, looking to a more uniform mix.

One of the difficulties encountered by the beginner in hauling ready-mixed or wet concrete is to get it out of the dump truck body, particularly if it happens to contain the least bit of excess water. A clean and well-polished iron body will usually clear without trouble. Some recommend that the body be oiled before the load is taken on, but care must be taken not to use an excess of oil, because it in turn will give trouble, according to the experience of one operator. It may also mix somewhat with the concrete and show oil stains over the surface, which, of course, would be very objectionable in any work where the concrete would be permanently exposed to view. A very good device is a sliding false bottom in the truck bed; it need not go quite all the way back to the end of the body; the front end of this false bottom should be bent up so that the top will be just above the height of the load of concrete; the false bottom should not be so wide that it will cause binding against the sides of the truck body when sliding; a piece of strong chain not over 12 in. long should connect the front of the false bottom with the front of the body, and care should be taken to shove the false bottom up against the front end before loading the concrete; then when the truck is dumped, the load and false bottom together move down until the chain comes up tight with a sudden pull, the jar of which causes the concrete to clear itself and move out of the body. One operator, who uses a locomotive crane to place and empty concrete boxes hauled to work on an industrial railroad, employs a jet of compressed air to clear out the corners of the boxes.

An article entitled, "Central-Plant-Mixed Concrete Tested for Maximum Safe Haul," appeared in the December, 1921, issue of *Public Roads.* The following is taken therefrom:

> The tests were made primarily for the purpose of determining the probable safe maximum length of haul for central-plant-mixed concrete to be used in the construction of a proposed experimental concrete road near Washington, D. C. The results are interesting, however, in a general way in that they show the relative strength and consistency of gravel concrete when hauled in a wet batch and tested at various periods of time up to three hours after initial mixing. The experiment was made in the following manner: Two batches of concrete in the proportion of 1:1½:3 were mixed in a stationary concrete mixing plant of 1 cu. yd. capacity. Potomac River sand and gravel were used as aggregates, the latter graded from 1½ in. to ¼ in. in size. An effort was made to mix each batch to a consistency having a slump of about 2 in., as measured by the truncated cone.
>
> After mixing, the concrete was dumped directly into a 3-ton truck, the wooden body of which had previously been divided into six compartments by means of transverse boards equally spaced and each about 1 ft. high. The concrete in these two batches was dumped so that each of these six compartments contained approximately ⅓ cu. yd. After making a slump test and casting 6-in. x 12-in. cylindrical specimens for compression test, the truck was run for 30 minutes, when the contents of the first compartment was sampled for consistency and strength. The concrete in compartment No. 1 was not dumped at this time, but was sampled in the truck, every effort being made to secure average samples. The truck was then run to the Arlington Experimental Station, a distance of 3 miles, where the contents of compartment No. 1 was dumped. Inasmuch as a dump body was not available for this experiment, it was necessary to shovel out the concrete by hand. Its consistency at this point, however, was such that it came out readily and would probably have dumped easily from a regulation dump body. After removing the concrete from compartment No. 1, the truck was run about the station roads for 15 minutes, returned to the starting point, and the contents of the second compartment deposited. Samples for both consistency and strength were likewise taken of this material, after which the operation of driving 15 minutes,

dumping and sampling was repeated until all of the concrete had been deposited.

The concrete had been mixed 3 hours and 10 minutes when the last section was removed. By this time it had become so hard that it was necessary to break it up with a pick. Up to section 6, however, it was possible to remove the concrete with shovels, and although very dry, segregation had not become especially marked. This may probably be accounted for by the fact that the concrete was mixed fairly dry in the first place, the initial slump being only about 2 in. It has been noted frequently that wet concrete will segregate more quickly and pack more readily during hauling than dry concrete.

The results of the tests for consistency, as well as the 28-day crushing strength tests, are given in Table 1. It will be noted that whereas the concrete became very dry after about one hour's haul, the strength of the cylinders prepared from the various batches was about all the same. In only one case was the strength much below the general average of 3500 lb. per sq. in.

Compartment. Number	Total Elapsed. Time,†		Slump	Crushing Strength Pounds Per Square Inch**		
	Hrs.	Min.	Inches.	(1)	(2)	Average
*	.	15	2	3,620	3,510	3,565
1	.	45	1	3,460	3,550	3,505
1	1	30	½	2,670	2,200	2,435
2	1	50	⅜	3,510	2,960	3,235
3	2	10	½	3,820	3,580	3,700
4	2	25	⅛	3,110	3,550	3,330
5	2	45	1/16	3,840	4,230	4,035
6	3	10	1/16	3,300	3,370	3,335

* Test made at plant.

† Time between initial mixing and sampling.

** Tests made on 6-in. x 12-in. cylinders of 1:1½:3 concrete at age of 28 days.

In connection with the construction of highways, the apparent savings of a central plant over a paving mixer operating on a subgrade are the following:

1. Elimination of wheelers and loaders—about 18 men.
2. Less wastage of materials—a saving estimated at from 4 to 5% of cost of sand and coarse aggregate.
3. Saving in cost of machinery used and a lower rate of depreciation.
4. Fewer delays due to mixer troubles.

The chief disadvantages in this operation is that delays in the trucking to the point of delivery hold up the job.

The central mixing plant does away absolutely with the obstruction to streets caused by huge piles of sand and gravel and the nuisance of smoke, dirt, and dust, which of necessity attends all construction work where the mixing is accomplished on the job. With the central plant it is rarely necessary that the entire street be closed to traffic, because no space is needed for piling up the necessary materials.

It can readily be understood that there will be practically no loss in materials when the concrete is handled from the central mixing plant.

Because concrete to be used for structural purposes must be wetter than most any other class of concrete, engineers have been slow to recommend a central mixing plant for the sale of pre-mixed concrete where it is to be so used. Concrete to be used in thin reinforced work, such as walls and columns in a building, should ordinarily have a slump of 6 to 7 in. It has been ascertained that concrete can be hauled long distances successfully when the slump does not go over 4 in., preferably not much over 2 in. In other words, the mixture should be what is termed very dry. Most of the concrete when it leaves the plant does not have enough water to make it glisten, and when it is being dropped into the hopper of the truck, it should pile up with slopes that are about equal to a 30° angle. Where it is necessary to transport, for any great distance, concrete with a slump greater than 4 in., as is needed in the case of reinforced concrete, it is believed that the difficulty accompanying the removal of this concrete from the truck body would overshadow the advantage of the central mixing plant. We have demonstrated, however, the fact that for a haul within a half-mile, it can be supplied wet enough to serve for any class of structural work. We are of the opinion also that some means of sprinkling the concrete for making it more moist at the point of delivery could easily be installed so as to make it wet enough for structural purposes, or so that it could be chuted to the actual location where it is being used.

There is also likelihood that a small amount of calcium chloride can be used to overcome the difficulties found in chuting concrete on structural work, but it must be remembered that the chloride hastens the time of the initial set. There is another benefit from the use of calcium chloride, namely, that it permits concreting to be carried on at a lower temperature than if it is not used.

PLANTS ARE SUCCESSFUL

Advice from the owners of plants that have been in operation for two or three years is, without exception, to the effect that they are successful. One advises that the labor cost is materially reduced and should not be over 50% of the cost for mixing concrete in the field. This is due to the fact that much labor can be eliminated by the use of machinery and gravity charging of the mixer. One plant in Philadelphia has been getting out a yearly average of somewhere between 60,000 and 70,000 cu. yds. The owner of a plant in Illinois advises that they frequently haul wet mixed concrete for 8 miles on pneumatic tires, and, by the way, it is well to state at this point that you should not attempt to haul mixed concrete beyond very short distances on anything except pneumatic tires. It is hardly necessary to add that the truck bed must be absolutely tight.

More or less opposition will be voiced when a central mixing plant is first put into operation. You must expect to have some of the concrete rejected at the job; but when you get everything working so smoothly at the plant that a uniform product is being turned out, or one that will not segregate when being transported to the work, you will be surprised how quickly the demand for ready-mixed concrete will increase.

It is unnecessary to explain to a body of contractors that economies over present methods ought to attend the operation of the central mixing plant as a general rule, because they can easily figure that such ought to be the result.

FROM ANOTHER AUTHORITY

The chief advantage of such plants is in the fact that the concrete can be more closely controlled in a central plant operated by men experienced in sieve analysis and the control of water-cement ratio than where the concrete is made in portable plants by a crew of laborers which is constantly changing. A comparatively small percentage of portable plants are equipped with an accurate measuring device for the mixer, and in most cases the aggregates for such plants are measured in wheel barrows which, even with the most careful supervision, is a very inaccurate method of measurement.

The developed knowledge of the last few years as to the control of quality in concrete gives a distinct opportunity to the commercially operated central plant.

Another advantage of such a plant is that it should be able to supply mixed concrete at a cost somewhat lower than it could be mixed for with a portable plant, particularly on small jobs where it would be necessary to carry the plant a considerable distance to the job, assemble all necessary materials, tools and special crew. The central plant would eliminate the necessity of mixing equipment for small contractors and the expense to them of moving and setting up the equipment on each job, as well as reducing the number of workmen required to feed the portable plant. A central plant would also make it possible for people who are inexperienced in making concrete to secure ready mixed concrete of very good quality for walks, driveways, garage floors, etc., which are frequently made by home owners.

The disadvantage of such a plant is that the consistency of the concrete is somewhat limited, as it does not seem possible to transport ready mixed concrete for any considerable distance unless it is of a rather stiff consistency. The wet or sloppy consistencies frequently used in building construction cause a rapid separation of the aggregates in transit, allowing the coarser aggregates to settle to the bottom with a gradation toward the top, where the cement and water soon accumulate on the top of the mass. It might be possible to dump such a mass into a charging hopper, where it would be remixed to some extent and discharged into wheelbarrows or concrete buggies. But, as the constant effort is away from sloppy mixtures, the central plant may be a sufficient factor of economy to offset difficulties in placing a slightly stiffer mixture.

The stiff mixtures used in road construction and sometimes in foundation work can be hauled a considerable distance with little or no separation of the aggregates. This has been demonstrated many times on road construction, where material has been hauled successfully more than 5½ miles, and often not being placed in its final position until more than 30 minutes after it has been mixed.

Graded Aggregate

Reinforcement for Roads

Announcement is made by Charles M. Upham, director of the Advisory Board on Highway Research of the National Research Council, that C. A. Hogentogler, of the U. S. Bureau of Public Roads, has been granted leave of absence in order to conduct for that Board a fact-finding survey of the economic value of reinforcement in concrete pavements. This survey is to be national in scope, and will be conducted in cooperation with agencies interested in this important subject. It is proposed to cover the various soils, traffic, and climatic conditions throughout the United States.

Mr. Hogentogler has had fifteen years of experience in highway construction and highway research, which well qualifies him to take charge of the present investigation. After graduation from the Pennsylvania State College, and a short period with the Pennsylvania Steel Co., he was with the Pennsylvania State Highway Department, followed by several years on street and road construction with the Borough of Columbia, Pennsylvania. For two years he was Assistant Professor of Civil Engineering at the University of Idaho. He was then engaged in research with the U. S. Bureau of Standards, and finally with the U. S. Bureau of Public Roads, in which organization he has been for the past six years.

* * *

A New Vibrator

In connection with making light weight structural units, 5 x 8 x 12 in., of a wet but stiff mixture in individual hand molds, Merrill Moore, Creston, Iowa, who is also the manufacturer of the molds, says that he has tried a number of vibrators in setting this mix into the molds, and the most satisfactory has been by using a pump jack which runs a heavy mallet under the 2 x 10 platform that the molds are set on. This strikes about 150 times per minute, and settles the stiff mix into the molds very rapidly. One man, with molds and mixture supplied to him, has made as many as 1000 block per hour with this equipment. Mr. Moore says a vibrator of this kind can be installed at a cost of about $25 provided power is already available. The molds used are made of 18 gauge galvanized sheet steel. They are carried in stock for making units 5 x 8 x 12 in.; 8 x 8 x 12 in.; and 8 x 8 x 16 in. Two 4 x 5 x 12-in. block can be made in each 5 x 8 x 12-in. mold. 5 x 8 x 12-in. block weigh 20 lb.; 8 x 8 x 16-in. block weigh 44 lb. Mr. Moore reports that such units are selling readily at $85.00 per M, in competition with clay units at $65.00 per M.

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Dwight L. Hoopingarner

Dwight L. Hoopingarner, who for some time has been serving as executive of the American Construction Council, has also taken on the job of director of the New York Building Congress. The work of the two organizations is along similar lines, one concerned with the greater New York district, the other national.

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Sewer Pipe Data

Concrete Pipe Sewers is the title of a new publication issued by the Portland Cement Association, which has a great deal in it that should be of value to engineers considering sewer pipe installations. It is 8½ x 11 in., with 30 pages and cover, and contains many illustrations and much data collected from engineers in regard to the use and installation of concrete pipe for sewer purposes, and engineering data which should be valuable for reference.

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Building Construction Courses

The Carnegie Institute of Technology, Pittsburgh, has issued a bulletin on building construction courses in bricklaying, masonry, and reinforced concrete. These courses have been meeting with considerable success, attracting students from all parts of the country. Eight weeks summer courses, one-, two-, and four-year courses—day or night courses—all are offered.

* * *

Massey Sells Hollowspun Pole Plant to Westinghouse

The Massey Concrete Products Corp., Chicago, has sold to the Westinghouse Electric & Manufacturing Co. its entire interest in the manufacture and sale of Hollowspun concrete posts and poles, including its plant at Milwaukee.

Since this department was confined to the Milwaukee plant exclusively, its sale in no way affects the activities of the Massey company in its other twelve plants, where reinforced concrete pipe, piles, cribbing, signal material, and other similar products for railroads and industries are manufactured.

* * *

Concrete and Aggregate Tests

Six standards and four tentative standards of the American Society for Testing Materials covering standard specifications and tests for concrete and concrete aggregates have been issued in a reprint by the Portland Cement Association, in order to have all of this material under one cover. Thirty-three pages and cover contain the following:

- Standard Method of Test for Unit Weight of Aggregate for Concrete
- Standard Methods of Making and Storing Specimens of Concrete in the Field
- Standard Method of Test for Quantity of Clay and Silt in Gravel for Highway Construction
- Tentative Method of Decantation Test for Sand and Other Fine Aggregates
- Tentative Methods of Making Compression Tests of Concrete
- Standard Specifications for Fire Tests of Materials and Construction
- Standard Method of Test for Organic Impurities in Sands for Concrete
- Standard Method of Test for Sieve Analyses of Aggregates for Concrete
- Tentative Specifications for Concrete Aggregates
- Tentative Rules for Inspection of Concrete and Reinforced Concrete Work.

* * *

Rensselaer Polytechnic

Rensselaer Polytechnic Institute will celebrate the 100th anniversary of its foundation with a special program participated in by representatives of many technical societies and institutions of learning of this country and abroad, October 3 and 4, at Troy, N. Y. Rensselaer Polytechnic Institute is the oldest college of science and engineering in any English-speaking country.

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The Building Situation

In view of statements current in some portions of the press that a depressed condition exists in the construction industry, the Department of Commerce has issued a statement (Sept. 2) calling attention to the immediate situation as compared with conditions a year ago. The value of contracts let in 36 states in July, 1924, shows an increase of 10% over that a year ago, and the total contracts let from January 1 to the end of July, 1924, also gained 10% over the same period of 1923. Practically all classes of construction contributed to the increase, although in varying degree, just as there has been relatively greater activity in some cities and districts than in others.

Residential contracts for July this year show an increase of 3% over those of last July; industrial and commercial building combined show 3% increase; public works and utility construction, 10% increase; educational buildings, 26% increase; and miscellaneous, including hospitals and institutions, religious and memorial buildings, and public buildings, 42% increase.

Cement shipments from the mills in July increased 21% over the same month last year, and for the 7 months ended July, were 4% higher.

Although there was some decrease in lumber production during the first 7 months of the year, orders for lumber, reported by 8 leading associations, during 6 weeks ending the middle of August show an increase of 29% over the same period of last year.

There has been some recession in the cost of construction. The Department of Commerce index number for frame house materials shows a decrease in 12 months from 214 to 199, compared with 1913 as 100, and for brick house materials, from 217 to 201. Other index numbers show a decrease in general construction costs from 222 to 214.

* * *

Building Costs to Remain at Present Level

Those who are looking for a general reduction in building costs in the near future will be disappointed in these expectations, according to S. W. Straus, president of S. W. Straus & Co. "As the fall season approaches, there is indicated the expectation upon the part of many that building costs are coming down," he said. "While there are always certain fluctuations in the costs of building materials, these advances and recessions are in large measure brought about through temporary local conditions, affecting prices in certain specific products.

"Economies in building are possible through increased efficiency. By a closer scrutiny of building operations and a more careful and scientific planning of buildings, it is often possible to produce at a much lower cost than would be the case if these intensive efficiency methods had not been applied."

Should there be any general reduction in building costs, it would be at the expense of building labor, and Mr. Straus is of the opinion that what would be gained in wage reductions would be lost in labor efficiency. The only circumstances under which labor would accept reductions in wages would be in the face of a sweeping reduction of all costs of living, which, according to Mr. Straus, would involve a sacrifice of values which is not desired by the people of the country.

"The more logical solution of the building problems is stabilization of costs at approximately present levels, and there are consistent evidences that such a development is taking place The abnormal activities which have been in evidence, particularly in the large cities of the country, for the last three years are being superseded by normal conditions. This cycle of building activity may be expected to produce stabilized costs, owing largely to the more evenly balanced conditions of supply and demand."

Fence Posts as a Side Line

Leo Brooks, Union City, Mich., has been making concrete fence posts as a side line, part time business, for 15 years. In this time, and by far the greater part of the total in the last few years, he has made 21,000 posts and sold most of them. He has been using a D. & A. mold outfit. Mr. Brooks says that in the first few years he did not sell many posts, as he was on a side road and devoted part of his time to post making, still he did sell many trial lots in scattered sections, and in later years these same customers came back for more as their older fences needed repairing or replacing. "The posts were their own salesman," says Mr. Brooks, "as neighbors, seeing the posts in use year after year were convinced that they were serviceable, and so inquired where they could get them, and they now come from far and near for them, some hauling them as far as 50 miles in trucks, but most of them only up to about 10 miles.

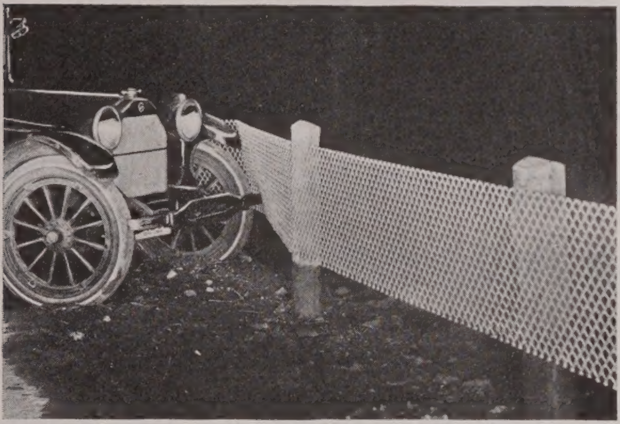
"During most of this time I have sold posts at prices that compared favorably with the prices of good wooden posts, some of my first ones selling 25 to 30¢ each, which was the same as good cedar posts were selling for at that time from the lumber yards. Several makes of steel posts have been introduced in my section, but they have never cut in on my customers, as they are higher priced and push over easily in the ground, and they do not last very long in wet marshy ground at least.

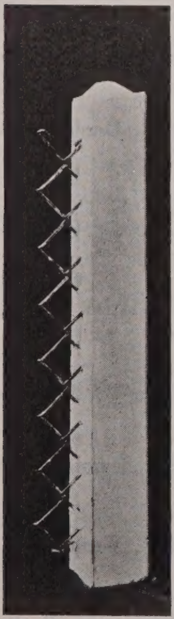
"I was all sold out last spring and could have sold more if I had them on hand, and so I intend to have a larger stock than ever for next winter and spring delivery, as I know the land owners about me have the confidence that my posts are the real thing, very few indeed having failed, and most of these by accidents where any post would have broken.

"The molds and process I am using are most practical and economical. Down at Coldwater, there are two other post makers turning out the same kind of posts, and I believe that they are selling more or less posts, and that all of us making the same post will help each other make sales, as the people are more easily convinced of their practicability than they would be if we were making several different styles of posts and running each other's products down in trying to make sales, which is the usual procedure."

Highway Guard Rail Like Life Net

An innovation in highway guards has recently been written into the standard specifications of a dozen or more states and made acceptable by the U. S. Bureau of Public Roads. It is shown in accompanying illustrations. This guard entirely discards the usual principle of guard rails, and is comprised of a white ribbon, 2 ft. wide, of heavy "link" wire, so fabricated as to stop a machine by the elasticity of its fabric, cushion fashion, and is, according to tests, strong enough to hold a car going as high as 35 or 40 miles an hour.





When erected, it looks something like a tennis net, and its rebound, when struck, simulates the idea of an aerial life net.

The new device is known as Hi-Way Guard, and is installed on heavy posts. While the majority of posts used in installations so far have been of wood, experiments carried on to improve this type of construction recently resulted in the development of satisfactory concrete end posts on an installation near Washington C. H., Ohio, and considerable strength has been added to other installations by setting steel or wooden posts in concrete.

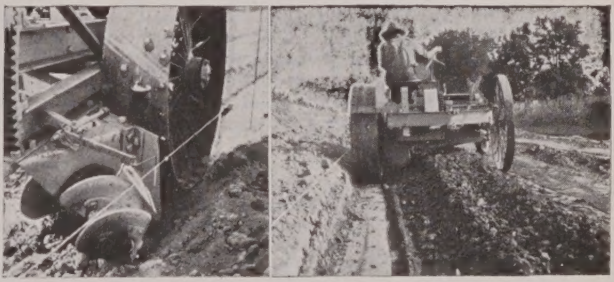
In the Washington C. H., installation, a short piece of the guard fabric was projected into the form for the concrete end post at the proper height, the fabric being secured to one of the reinforcing rods. After the concrete was poured and had hardened, the short section of fabric projected from the post, as illustrated. This short section was then coupled to the adjoining fabric by screwing a picket into the ends that were brought together.

Another interesting installation was recently made on Cedar Hill in Cleveland Heights, Ohio, where 593 linear feet of the fabric is guarding a main boulevard that carries a maximum of 3100 cars an hour. The fabric is 24 in. wide, with a 2-in. square mesh of No. 6 wire. Ninety feet was erected on 10-ft. centers on 2-in. steel posts 7½ ft. long, set 50 in. in concrete, and the balance on wooden posts 7 ft. long, set 43 in. in concrete, the tops of the wooden posts being machine turned to 6 in. diameter and the bottoms creosoted. Both types of posts were given two coats of white paint to insure visibility, once before and once after they were set in the solid concrete blocks. The total cost, including paint, brushes, staples, cement, gravel, etc., is reported as 66.4¢ per linear foot.

W. T. Kyle, general manager of the Page Steel & Wire Co., invented the new guard, following two years of experimenting in an effort to produce a perfect buffer, functioning much like an automobile bumper, in fabricated wire.

Road Formgrader

A new Formgrader has been brought out by Edward G. Carr, 224 West Huron St., Chicago, adapted to the new thickened edge cross section of pavement. It is equipped with a Ford automobile engine for power. The announcement of the equipment says it will cut a form trench up to 1 ft. deep and 1 ft. wide, as well as the slope up on the inside. It will cut this form trench 1 ft. wide and 6 in. deep, together with the slope on the inside, and remove the dirt, in one trip over.



A rotary cutter is driven immediately in front of the big rear wheel, the depth being controlled by a hand wheel and a gauge, running against the chalk line with hair spring pressure. This gauge is actuated by a pendulum, so that any tilting of the machine would not cause any variation in the grade cut below the line.

The machine has working speeds of from 7 to 15 ft. a minute, and a traveling speed of 3 mi. an hour.

Not only will this cut hard ground to exactly the right height for supporting the forms, but it is also a means for rolling down soft ground where the forms are to be set.

The machine illustrated is on the Duncan Construction Co. job at Champaign, Ill. (State Aid Job, Route 17, Section 34-15D, Philo Road), where they are laying a 9-ft. pavement, and running from 1000 to 1400 ft. a day, and according to Mr. Verhey, on the job, the Formgrader has done away with his entire crew digging the form trench, and by cutting out the shoulder next to the form, it has been a great aid to subgrading.

If you have an idea that has "worked" for you, pass it on—exchange it through CONCRETE for other ideas.

New Ideal Tamper

The Ideal Concrete Machinery Co., Cincinnati, is manufacturing a new tamper which was designed to meet the demand of small operators for an efficient multi-use machine at a comparatively small investment. The Fit-All, as this tamper is called, derives its name from the fact that it may be used over any face-down or hand stripper two- or three-core machine of any make, and embodies many improvements that are said to save time, labor, and money for the operator.

Trade Publications

The Reliance Chip and Sand Spreader, Universal Road Machinery Co., Kingston, N. Y. A 4-page illustrated circular describing and illustrating the Reliance chip and sand spreader, new road maintenance equipment which can be hauled or pushed, and is designed to be operated by a tractor, truck, or roller. It spreads to a width of 8 ft.

Jaw crushers, *hammer pulverizers*, *elevators*, *screens*, and auxiliary equipment are illustrated and described in a new circular issued by the Universal Crusher Co., Cedar Rapids, Iowa, manufacturers of the equipment. They have just moved into a brand new and larger plant.

The Koehring Co., Milwaukee, Wis., has issued a pocket size folder, very attractively printed, illustrating and describing very briefly the Koehring group of products, about which more detailed information may be had by anyone interested. This line includes pavers, trailers, construction mixers, light mixers, bar benders, bar cutters, gasoline cranes, draglines, shovels.

The Maroa brick-cleaning machine, Model No. 3, is the subject matter of a circular issued by the Maroa Manufacturing Co., Maroa, Ill. The machine is designed to clean the mortar off used brick. A number of cutters working in opposite directions at the speed of an ordinary drill, being operated by intermeshing steel cut gears. The manufacturers say the softest brick may be cleaned with the device without breaking, and that the saving alone on broken brick will average $4.00 a day over hand methods on the quantity cleaned.

Literature of the Truscon Laboratories announces a new product, Super Por-Seal, a transparent damp-proofing intended as a surface application over concrete, stucco, brick, and masonry. The manufacturers announce that while transparent damp-proofings are not new on the market, Super Por-Seal represents a departure in the fact that most of the materials on the market have been made with waxes, petroleum, or other mineral oil bases. The Truscon Laboratories have a material of this kind, known as Por-Seal. In general composition the new material is much like Truscon waterproofing paste, except that it is in a clear solution, and the public is assured that it does not darken or discolor the surface of a wall.

Miles Concrete Equipment, *block machines*, *automatic power tampers*, *continuous mixers*—a 52-page catalog, 7½ x 10½ in., issued by the Miles Manufacturing Co., Jackson, Mich., illustrating and describing Miles block machines, automatic power tampers, simplex continuous mixers, face plates for block design, pier and chimney molds, and presenting a considerable number of photographs of interesting work done with concrete building units. With all this material, there are also presented several plans of concrete masonry unit houses.

The Concrete Dope Book, 4th edition, is compiled and published by W. H. Stewart, Waterloo, Iowa. It contains handy tables, such as: Materials for 1 yd. of concrete in various mixtures; Materials for 100 sq. ft. of sidewalk concrete base or grout; Cost of 1000 sq. ft. of sidewalk at various prices of material. The booklet contains 16 pages in an attractive cover. It is priced at 25c.

The Besser Line of Concrete Products, *Machinery*, *and Equipment* is very handsomely and impressively set forth in a new loose-leaf catalog issued by the Bessers Sales Co., Monadnock building, Chicago. It includes an announcement of the policy of the company and its personnel, and assembles separate prints and descriptions of various items of equipment, together with numerous letters testifying to the satisfactory use of Besser equipment in the manufacture of concrete units. The book covers block, brick, and lightweight tile, rack cars and transfer cars. It shows not only the individual items of equipment in some detail, but has an interesting collection of pictures showing the equipment in use in successful products plants. Descriptions are also presented of the Besser batch and continuous mixers in connection with skip loaders and other auxiliary equipment.

Truscon Copper Steel Standard Lintels is the subject matter of a circular issued by the Truscon Steel Co., Youngstown, Ohio. They are a development subsequent to the Truscon steel windows, and represent still further economy, according to the manufacturers, in this part of building. They are finished in various standard sizes for basement windows, single and double casements, and for standard stock windows.

The Right Angle, issued every once in a while by the General Fireproofing Co., Youngstown, Ohio, is published of course to help sell the materials the General Fireproofing Co. has to offer. The July, 1924, issue, however, is the Schoolhouse Number, and it has some very interesting things in it, among them articles under the following titles: Steel Lumber Construction for Schoolhouse Floors and Partitions; Steel Tile Floor Construction for Schools; Finishing Interior Walls of Schools; How to Make Schoolhouse Floors Durable, Hygienic, and Attractive; followed by some construction details on general fireproofing products.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit. Convention, Chicago, February 24-27, 1925.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R, Borrows, Acting Secretary, 903 Munsey Bldg., Washington. D. C.

Portland Cement Association; William M. Kinney, Genera Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.